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THE WILDLIFE MANAGEMENT INSTITUTE wishes to express its appreciation to the Wildlife Society and to the many individuals, organizations and agencies that contributed to the success of the Twenty-third North American Wildlife Conference.

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PART I

GENERAL SESSIONS

GENERAL SESSIONS

Monday Morning—March 3

Chairman: Delyte W. Morris
President, Southern Illinois University, Carbondale, Illinois

Vice-Chairman: Monroe Bush
Assistant to the President, Old Dominion Foundation, Washington, D. C.

TODAY'S OPPORTUNITIES FOR CONSERVATION

FORMAL OPENING

Ira N. Gabrielson

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

It is a great pleasure for me to be here again to open the North American Wildlife Conference and to see so many old friends and so many new faces. We hope that you will have a good time and that you will do a little work while you are here.

As I generally do, I want to say that this is a conference, not a convention, and we have asked the chairmen of the meetings not to entertain or to offer motions because this conference is made up of representatives of many organizations, officials of various governmental agencies as well as individuals, and so this is not the place for resolutions or action. Those actions properly belong in the meetings of the organizations that are represented here or of the official agencies. What you may learn here and take back to your organization is your problem and not ours.

The Program Committee finally got me to break a rule that I have not broken since I have been with this organization and that is to make a talk on the program. Any remarks, complimentary or otherwise, that I may have to make will be in my scheduled talk on Wednesday afternoon.

However, I think it might be all right to review briefly a few things that we might keep in mind. There are, in addition to the usual complexities and difficulties that are always present in a democratic form of government, three existing factors that I think may affect conservation programs all over the nation.

In the first place, this is an election year, and anything that is done in Washington and, to a large extent, in the state capitols, will reflect this fact one way or another. The reactions of nearly everyone will be tinted and tinged to a certain extent with political hopes and aspirations, and we should take that into consideration.

Secondly, the satellites are being blamed and credited with many things, and the fact alone that man has been able to send objects into space for the first time certainly is momentous. But much of the speculation and excitement about them is, I suspect, somewhat premature. It will probably be a considerable period of time before the possibilities that are unfolded by that accomplishment begin to affect our daily lives, except psychologically. I notice that the Army engineers are already using it to promote some of their projects.

I have seen statements indicating that, because of the satellites, we had to drain more marshes in Louisiana, faster than they had ever been drained before, or to drain more potholes in the Dakotas than we had in the past, or to build more big dams somewhere for some mysterious reason.

Just how these will affect the coming space age that is only sticking its nose above the horizon, I am not able to fathom. Neither am I able to see any crisis that would justify a stepped-up program to develop more agricultural land in a country that is cursed with five billion dollars' worth of agricultural subsidies to keep up farm prices. I don't think that we are going to change that right away. We have developed better methods of cultivation; fewer people are producing more all of the time, and the need for more agricultural land that is used to justify some of these schemes seems a little far-fetched to me.

We will hear more about all of these projects, particularly the controversial ones and those that have objectionable features. We will hear more about them because we are supposed to have to do these things in the coming space age to a degree depending upon your political beliefs or upon the political beliefs of others.

We are presently experiencing a great depression or recession or business adjustment—you can choose your own terms. The truth is that the political world is already speculating on how to meet this particular contingency. There have been innumerable bills introduced in the Congress for furthering and furnishing employment. Nobody knows what will come out of them. However, there will be many kinds of programs and they will be used to justify projects that otherwise could not be justified. Those of you who are old enough will remember the depression days of the 'thirties. We had many devices, some of them good, some of them not so good, for furnishing employment. I see that there are bills already introduced to revive the Civilian Conservation Corps or some similar agency; and, in passing, I can say, in spite of many mistakes that were made in it, that program did much good and helped to make America a much better place in which to live.

Whatever comes out of this, either at the state or federal level, if there is continued widespread unemployment, we can expect public works programs of one kind or another. They can be leaf-raking programs or they can be useful programs, and it is up to us as voters and taxpayers to see that we get as much good and as little waste out of these programs as possible.

To me, such programs would represent an opportunity to do a better job of managing the basic resources on which we depend. We have many more sound existing programs that we could accelerate if there is the need for more public works expenditures than we had in the 'thirties.

The small watersheds program could be profitably accelerated. We have Mission 66 of the Park Service. We have the new program of the Fish and Wildlife Service, which hasn't yet gotten off the ground. We need money to implement it, money and manpower, and there isn't a state conservation organization in the country that hasn't a better program than that same organization had in the 'thirties and could not use more money to speed it up.

So, while we are talking during this convention about our everyday problems and of things of immediate concern, let's think about these future possibilities. It may represent an opportunity, and money that is spent for natural resource management and development, no matter what phases of it, is going to be wasted less than it would be in some of the programs that we had back in the 'thirties.

Let's be alert, all of us, now. If we are not ready, then let's get ready, so that, if there is a vast outpouring of public funds comparable to that in the 'thirties, we can take advantage of it and use the money for a real public purpose.

INTRODUCTORY REMARKS OF THE CHAIRMAN

DELYTE W. MORRIS

To a person who is not in the midst of one of the group conservation activities in this nation today, it is fairly obvious that there are about as many different approaches to conservation as there are groups and people interested in it.

I think that one might set down as two extremes what might be called the static approach on the part of those who wish to leave things as they are, and the dynamic approach on the part of those who realize that we live in a changing world, that this world is undergoing vast changes, and who think of conservation as fitting into this dynamic program.

As we look at the program outline for this morning, it is clearly constructed in terms of a dynamic approach to conservation. Its very heading implies it. Also, as we look at the various subjects listed under the general heading, we see a tie-in between the land of the people and the growth of the people, the development of the people and the utilization of nature by man, and man's need for nature. This dynamic approach, which relates to the growth of people and times, is the one which, in education, we think of as being the only ultimate, workable and real approach.

Those of us in education, you know, are very single-minded. We feel that if you want to get something done over a period of time with any group of people, whether in a village, state, region or nation, you start with the children and teach to those children certain attitudes. Then, as those children grow into men and women, you will have changed, within a generation of people, a national attitude.

There has been in our day, fortunately, in the last generation, a growing attention to matters of conservation approached through various channels. One of the most direct we have been calling the outdoor educational field. We must take the boys and girls out of the small communities, as well as the large, and see that they have pleasant, informative, worth-while experiences in the great outdoors; that they learn an appreciation and an understanding for the things of nature; that they come to realize the complete dependence, the complete reliance we must have upon the land and the things that it produces. If this program of outdoor education in our schools can, in the next generation, be enlarged and developed and extended so that it reaches enough of the young people, I think those who have worked so long and labored so hard as minority groups will find a great ground swell of support coming from this new attitude which may be developed. Those of us in education hope so.

The program as we look at it today is geared to the kind of multi-approach which promises much in the field of conservation.

TODAY'S OPPORTUNITIES FOR CONSERVATION IN AGRICULTURAL DEVELOPMENT

D. A. WILLIAMS

Administrator, Soil Conservation Service, U. S. Department of Agriculture, Washington, D. C.

I welcome this opportunity to bring to you a report on the objectives and accomplishments in the soil and water conservation program in the United States. I propose to discuss with you some of the opportunities inherent in soil and water conservation work on agricultural lands, not only as that work affects crops of fibers and foods, but also as it relates so very directly to wildlife as another important product of agricultural land.

One of the most articulate conservationists of all time said, simply: "Conservation is a state of harmony between men and land."

But harmony doesn't just happen, as Aldo Leopold hastened to recognize by pleading eloquently for a "land ethic" that would guide man's behavior and help him to achieve that harmony.

Harmony, be it between nations in the world community or between man and nature, is gained only by great effort and maintained only by great vigilance. The word exists because there is another and opposing condition. Eighteen centuries ago Plutarch sagely commented: "Medicine, to produce health has to examine disease, and music, to create harmony, must investigate discord."

Conservation of the soil, water, grass, timber and wildlife resources of our country is a constant, uphill struggle against the many forces and influences which man and nature oppose to that harmony Leopold used as a definition and measure of conservation.

Conservation becomes particularly more urgent as well as more difficult as the earth's human population grows. The problems created by our population "explosion" differ somewhat in the several fields of agriculture, wildlife and recreation, forestry, water supply, urban and industrial planning. Yet these are differences only in detail and perspective. The basic effect is the same: more and more pressure on less and less land for more of everything that land provides. More food, more fiber, more wood, more water, more wildlife, more recreation, and more room for just living and working!

To achieve conservation, therefore, we not only have to solve many difficult physical and technical problems. We also must arrive at social, political, intellectual compromises that will eliminate or effectively diminish the hindrances caused by land-use conflicts.

How can this vast problem best be approached? Where is the handhold that gives us a first grip on the problem?

I am sure there will be little argument if I propose that a large part of the solution can be found in the field of agriculture and in the hands of the private owners and operators of land.

Land, together with its component elements of soil, water, grass, trees and wildlife, is the physical objective of conservation. But who determines land use?

About four-fifths of all our land is in farms or used for grazing by farmers or ranchers. Most of our water falls on agricultural land and is therefore first of all an agricultural resource. Most of our timber grows on privately owned land.

Thus, any approach to the land of necessity must be mainly through its use for agriculture, and through the attitudes and actions of the men and women who, under our cherished American system, have great latitude in the management of their affairs and their property, including land.

This is no less true when it comes to wildlife conservation. Four-fifths of the game produced and hunted is on land under private control, and mainly on land owned or leased for the growing of crops or for grazing.

But agriculture is not necessarily inimical to wildlife. It is true that agriculture does displace some wildlife by altering its habitat. At the same time, agriculture creates new habitats—for the same kinds of wildlife at other locations, or for other kinds of wildlife whose requirements are better served by an agricultural landscape. As a result, there is probably more wildlife today than when our forefathers first saw our land.

As you travel almost anywhere in our country today, you can see the evidences of conservation progress based on a new concept of conservation. Modern soil and water conservation means putting to work on the land needed combinations of effective practices—combinations planned for and fitted to each acre of land, according to the use for which that land is best suited.

Such a land-use pattern, that respects the natural capabilities of the land, of a necessity includes a place for wildlife. Some land, uniquely suited to wildlife, is permanently dedicated to that use. The farm or ranch, planned and managed as a whole, produces wildlife as a primary crop of such areas, and as a by-product of the entire land unit.

Thus it is that modern conservation planning preserves countless acres of wetlands that would have been drained under the less scientific programs of 30 years ago. And the new water areas created by thousands of farm ponds and by hundreds of larger impoundments in watershed projects replace—in part at least—the wet areas that must yield to agricultural use. This is but one example of the way in which soil and water conservation preserves and creates wildlife habitat.

We still have a long way to go, of course, to reach that full measure of man in harmony with land. But I think we have made a fair start.

If it is a good start, should we not analyze how this much progress has come about? It may be a guide and a means of going the rest of the way more quickly and efficiently.

Much of the credit goes to you dedicated conservationists in the groups and organizations represented here at this North American Wildlife Conference. You have recognized that wildlife populations could not be sustained and improved unless the land itself was improved. You have worked aggressively, on the land, in education, in the legislatures and in Congress, to bring about needed understanding and needed programs. You have militantly opposed actions you believed contrary to conservation goals. You have written and talked and persuaded and organized to draw attention to problems of the land and to stimulate action on those problems. The nation today and in future generations owes you much for your zeal and effort.

But you cannot do the job alone.

Conservation programs enacted by the Congress and carried out by agencies of the federal government have also played an important part in achieving this much progress. The need for government participation in this vital area was recognized long ago by far-sighted leaders in both the executive and legislative branches. Much of this government responsibility has come to the Soil Conservation Service which now has whole or partial responsibility for administering or providing technical assistance in soil and water conservation on fifteen programs in the Department of Agriculture.

Without going into statistical details, let me merely report that last year the Soil Conservation Service helped more than one million farmers in soil conservation districts to develop conservation plans, revise existing plans or to apply parts of their conservation plans. Soil surveys, which provide a sound basis for planning conservation, have been completed on more than a half billion acres.

Since the Watershed Protection and Flood Prevention Act was passed in 1954, more than 800 local organizations have applied for aid in developing watershed projects. Of this number, 310 have been approved for planning, and operations have been started on 69 projects.

But, I hasten to say, too, that the Soil Conservation Service has not been the only federal agency involved in the progress charted to date. Agricultural research has focused increasing resources on the problems of soil, water and vegetation. The cost-sharing aid extended through the Agricultural Conservation Program, the Conservation Reserve, and the credit programs adapted to conservation by the Farmers Home Administration have played an important part. The Forest Service and Federal Extension Service have aided and encouraged the state forestry and extension services to bring effective conservation help to farmers and ranchers. These and other agencies have joined to develop such special programs as the Great Plains Conservation Program where a combination of conservation aids is, for the first time, being related to a single long-range conservation plan as a means of stabilizing agriculture in that area of high climatic hazards.

Still, government cannot, and should not, do this job alone. Private industry, increasingly conscious of the stake business has in a sound resource base, has made significant contributions to this movement, as have educators, civic, religious and many other groups.

In the final analysis, however, responsibility for conservation rests mainly, as I said earlier, with the people who own and operate the land. The "land ethic" Leopold sought obviously cannot be or have force until it exists in the minds of men who own and use the land. These are the people who have made by far the greatest contribution to the conservation progress we note today.

Fortunately, as evidenced by the fact that conservation progress has been made, there has been a most gratifying acceptance of conservation responsibility by farmers and ranchers. Most farmers and ranchers love the land, know it and treat it well. Also, farmers and ranchers have found that conservation practices increase their income. Modern farming is, after all, a business and a farm is operated to make money.

But our conservation progress stems from something more. The existence, in the form of soil conservation districts, of *organized,* local conservation effort by farmers and ranchers has, in my opinion, been the single greatest factor in the distance we have traveled thus far toward conservation of our total land resources.

Conceived 20 years ago as a hopeful experiment in the mechanics of operating a national soil and water conservation program, these soil conservation districts—2,779 of them today—have emerged as a unique example of successful local leadership of a program that must involve participation of government at local, state and national levels, as well as other segments of society—all focusing on the farmer and his land.

Today these districts include about 93 percent of all the farms and ranches of the country, and about 88 percent of the farmland. The districts have 1,728,000 cooperators—with a 37 percent increase in the last five years alone. This body of districts is more than a useful mechanism for channeling educational, technical and other conservation programs to the land. It is, in addition, a tremendous, vital, local, conservation-minded segment of the agricultural population of the United States. Its governing bodies alone comprise some 14,000 local conservation leaders who, in turn, are banded together state by state and nationally into a group whose voice for conservation is strong and growing stronger.

Rapid as the development of soil conservation districts has been, it is safe to say that they have not yet begun to perform their full service to conservation. And that brings me to the main point of this discussion:

The time is right for sportsmen and wildlife organizations to join with soil conservation districts in a potent working relationship that will benefit all land resources and all users of these resources.

I know of no other approach to the solution of basic soil, water and wildlife conservation problems that can equal the potential of such a partnership. I know of no other farm group or farm program so receptive to the objectives and needs of sportsmen and wildlife conservationists as the soil conservation districts.

More than one of the leaders in your wildlife organizations has affirmed that the work of soil conservation districts has done more for wildlife in the past twenty years than any other farm program.

But that must not leave the implication that wildlife values have been purely incidental in the soil conservation district programs. From the start, specific wildlife improvement practices have been incorporated into the farm and ranch conservation plans which soil conservation district cooperators develop and carry out. Over and above the widespread benefits to wildlife of plantings and water development for general farm improvement, nearly 4 million acres of special wildlife areas have been developed in soil conservation districts. The one and one-half million surface acres in farm ponds certainly provide more than incidental wildlife benefits.

In one soil conservation district in Wisconsin, farmers last year put 307 acres of agricultural lands to specific wildlife use—more than six times the amount in any previous year. In one 8-county area of South Carolina, 111,622 acres of farmland in districts have been planned and developed with wildlife as the primary land use, establishing lespedeza bicolor and other valuable wildlife plants in odd areas, power line rights-of-way, and in field borders. In Florida, districts have set aside 253,000 acres of privately owned land for wildlife improvement. This is made up mainly of land devoted to hedgerows, shrubby areas, swamps and marsh areas.

In West Virginia, since 1943, 13 million multiflora seedlings have been planted in 2,400 miles of fence. One district cooperator there recently checked his multiflora fence, established as part of his conservation plan. He counted 47 birds' nests in less than 100 feet of hedge.

To further this type of work, the Soil Conservation Service employs a number of biologists who train and advise our conservationists in recognition of wildlife opportunities in farm and ranch planning. These men work in close cooperation with the technicians of the federal and state wildlife agencies.

The state game and fish departments in a number of states have formal working agreements with soil conservation districts. In other states working arrangements are informal. Where this cooperation exists, the State wildlife agency may help the district develop the wildlife phase of its program, often provides free planting stock, helps in planning and installing wildlife practices, sometimes provides fish for stocking of ponds, and other services. In return, cooperating farmers provide planting sites, protect plantings and the wildlife, cooperate in game management and propagation. As just one example, 800 farmers in the Robert E. Lee district of Virginia planted wildlife areas on their farms in 1957. More than 5 tons of planting material were distributed to these farmers by the Virginia Commission of Game and Inland Fisheries.

Certainly, it would seem that districts offer an opportunity to work with farmers more effectively in the farm game habitat programs under way in 40 or more States.

I was disappointed to learn, however, that out of all the State Associations of Soil Conservation District Supervisors, only one has a working agreement with the organized sportsmen of the State. This would appear to be such a logical means of working toward improved farmer-sportsman relations and greater progress on wildlife conservation.

In asking our SCS offices in the States for some of the information I've just cited, I urged them to send along a few good up-to-date examples of the attention soil conservation districts are giving to wildlife conservation. The response was surprising and gratifying, for I received more than 350 items which we tried to classify, roughly, in terms of the main topic contained in each report or account.

Seventy-five described development of ponds or other fishing waters. Seventy dealt mainly with vegetative improvement programs for wildlife generally. Forty-five dealt specifically with improvement of waterfowl areas. Thirty related to cooperation with sportsman clubs. Eighteen described projects for improvement of habitat for game birds. Sixteen were stories about the use of Conservation Reserve wildlife practices in districts. The remainder were divided between such topics as marsh improvement for furbearers, youth programs in wildlife conservation, wildlife aspects of watershed programs, and the like.

They indicated that a considerable number of sportsman clubs have recently obtained run-down farms and solicited district aid in converting them to productive wildlife areas.

A considerable number of farmers or ranchers, retired or no longer needing their land for crops, have used help of the district and the wildlife agencies to convert entire areas into wildlife havens or hunting areas.

A gratifying number of reports told of teamwork between a farmer or group of farmers and a nearby sportsman club. In South Dakota, where the State Izaak Walton League makes annual awards to farmers for creation of wildlife habitat, the first, second and third place winners in 1957 were soil conservation district cooperators.

I have no basis for guessing what percentage of the total activity these reports represent. I can only say that I was pleased to see a sample which indicated such a considerable volume and variety of cooperative activities between districts and wildlife organizations.

There was, however, a serious jarring note. In a number of instances, I found a notation accompanying an unpublished item which said the farmer had asked that his wildlife improvement work not be publicized.

You don't need another reminder of this problem, but in this area of farmer-sportsman relations, too, farmers in soil conservation districts are beginning to take the lead. Several examples were called to my attention where it was a soil conservation district supervisor, or a leader in the district, who had taken the initiative in organizing a farmer-sportsman club for the mutual benefit of both groups.

That sort of thing could be developed locally in hundreds or thousands of soil conservation districts with the proper national, state and local encouragement.

Conservation farmers and sportsmen have much to offer each other. Farmers are, of course, the owners and custodians of the land on which sportsmen want to hunt. They protect and feed the wildlife, even though they do not own it. They can manipulate the environment in such a way as to increase wildlife populations. They can create dual-purpose water developments which serve both agricultural and recreational purposes. They represent respected farm leadership in the community and can influence adoption of favorable wildlife activities. Through their newsletters and other media of information, they can publicize wildlife conservation opportunities.

Sportsmen, on the other hand, have much to offer to conservation-minded farm neighbors. They can support, locally and nationally, the programs and developments that will strengthen and help soil conservation districts. They can help non-farm people to understand farm problems. They can help others to see that wildlife comes from agricultural lands—that wildlife is a crop—as truly as corn, forage or trees—to be produced by conscious land management. Many farmers are themselves ardent sportsmen, and would welcome further association with organized sportsman groups. Sportsmen can find ways of giving one or a group of farmers specific help in a conservation practice or development of value and benefit to the farmer, to the sportsman, and to the community.

They can assure farmers that they will be adequately compensated for extra effort or sacrifice of income incurred in producing wildlife harvested by sportsmen. They can develop means of protecting the farmer from undue harassment by hunters or fishermen.

Both groups can do this in the knowledge that working together to conserve these resources, they can each reap from the land those products and pleasures which it can yield so bountifully when it is used and developed to its greatest capabilities.

Speaking for the Soil Conservation Service, I can say that we shall continue to deal with wildlife as an inseparable part of the total ecological community on all land. We shall continue to seek the co-operation and assistance of the technical wildlife agencies in biology research and in the development of improved wildlife management techniques. We shall further encourage the farmers and ranchers we assist in soil conservation districts and watershed projects to take positive action on wildlife improvements as conservation works are planned and executed.

America *can* have productive farms and abundant wildlife—at the same time!

DISCUSSION

MR. STUART BRANDBORG [National Wildlife Federation]: I would like to ask Mr. Williams how he relates the rural development program of the Department of Agriculture to this broad educational job which we have to do with the many lay groups and agencies who are sharing with us this common concern for making better use of our lands? As I understand it, the rural development program makes provision for drawing together our federal, state and local agencies in a broad educational effort, a program which will mobilize the very best of our human resources at the local level by drawing the agencies and the citizen groups, the soil conservation district groups, the sportsmen and so on together to study their local conservation needs and the solutions that might be developed to meet this.

I would like to have Mr. Williams evaluate this program and tell us more about it if he would.

MR. WILLIAMS: The rural development program is really a concept. It is not a program which is centrally developed and directed from Washington. It is a concept for community improvement at the county level in which all interests, rural and urban, can join together to the point where it is necessary to further the economic situation in a given area, through improved labor opportunities, through improved industrial relations and also with respect to the land and the conservation of natural resources. The actual program carried out locally is a program developed by a committee of local citizens—a program in which they visualize the need for making certain adjustments in land use or in land opportunity or what have you for their community. Educational assistance is provided to the local committee from the state level under the leadership of the state extension directors, in most places, but with the cooperation of the agencies of the Department of Agriculture. There has been made available to certain agencies of the Department of Agriculture, by Congress, some resources to step up or strengthen the work in selected or designated pilot counties in the United States and those pilot counties were designated by the Secretary upon the recommendation of the states to receive certain of this extra assistance.

Attention is being given to the land resources as well as the labor resources and the other factors that go into the picture to improve community living in these pilot counties across the country.

MR. BRANDBORG: That is most helpful. However, do you feel that this is a natural opportunity for us to draw interested groups together for the purpose of studying our land-use problems and developing a unified program for reaching some of the solutions to these very broad problems?

MR. WILLIAMS: I think that this rural development program offers another real opportunity in that direction. I don't think it is going to be a magic wand that will solve all the problems, but in view of the fact that a local committee of citizens is endeavoring to see what the future has in store for its community, of which land and water resources and things related to them are a part, I think it is highly desirable that professional and organizational leadership offer facilities at their disposal to work with that local committee to help them to see what some of the other important factors are. However, government cannot run the program for the people—it must be run by the people themselves. The local people must design those extra facilities that will be helpful in carrying out the objectives they seek.

VICE-CHAIRMAN BUSH: I would like to ask Mr. Williams if he would elaborate on what struck me as a very interesting sentence. He said, "to achieve conservation, therefore, we not only have to solve many difficult physical and technical problems, but we also must arrive at social, political and intellectual compromises that eliminate or effectively diminish hindrance caused by land use conflicts."

MR. WILLIAMS: I will be happy to try.

In a democracy we operate on the basis of people having the opportunity to express different points of view, and that opportunity is basic to the preservation of a democracy. It is important that people do make such expressions, but then these points of view cannot all be alike because people differ in their background and in their interests. Therefore, in practically all actions in a democracy, all decisions are based on compromises. That is the historic pattern of democracy and, of course, those compromises involve social, political, and other factors.

I think that the most important factor of all is whether men and women have the conservation concept, based upon the fundamental provision of American democracy, that will move forward objectively, in spite of compromise, to get the job done that is best for the country.

TODAY'S OPPORTUNITIES FOR CONSERVATION IN FORESTS, PARKS, AND WILDERNESS

A. W. GREELEY

Regional Forester, U. S. Forest Service, Milwaukee, Wisconsin

The theme of this meeting, "Conservation In An Expanding Economy," and the subject under consideration this morning, "Today's Opportunities For Conservation," are topics that need the continuing attention of all the groups that support the North American Wildlife Conference. Professionals in the various natural resource fields tend to take for granted the importance of the conservation concept as they see it. Non-professionals who are enthusiasts about a particular phase of natural resource use have a tendency to think primarily about their own interest field. I believe this program this morning is especially timely to focus attention once again on the broad endeavor which is the common field of interest of all of us here.

Why should we be concerned about the fact that our economy is expanding?

Of all the figures that are bandied about concerning our economy, the ones that mean the most to me are those on population. The Bureau of the Census now estimates our population at 173,000,000, with a gain during the past year of over 3,000,000 people. That rate of increase shows little sign of easing off. That's an increase of over 30 million people in ten years, and 60 million in twenty. We now commonly talk of a 300 million population by the year 2000.

With our resources already under pressure from our present population, we can all do some sober thinking about the impacts of another 60 million people in twenty years. And we can worry, too, about the shorter work week that seems to be ahead, the higher standard of living, and the ease of travel over our system of superhighways.

The forestry profession helped to develop in this country the concept of conservation as meaning wise use, and as involving the interrelationship of all resources. But, of course, foresters have no corner on this concept. In fact, the very word "conservation" has come to have its own meaning to different people. Common meanings range from that of producing and using more of some desired object or service, through the concept of wise use of existing resources, to the thought of simply preserving resources of various kinds.

In this paper, I am using the word "conservation" as meaning responsible and constructive concern about the present and future relationship between natural resources and human resources.

So, I would like to talk today about conservation as a very broad area for action, one that encompasses all natural resource fields and that also infers a concern about public interest and long-term public welfare. In that framework, opportunities for conservation in our day abound on all sides.

Forests, parks, and wilderness have at least one common denominator for this discussion of conservation opportunities. They are wild lands. Wild lands do not support the level of economic activity that cultivated lands do. They do not entail the same level of land values as cultivated lands, nor do they support the same intensity of population. Changes in the way wild lands are used are much more difficult to bring about than is true of cultivated or urban lands. Such changes usually come about through the long-term effect of economic forces, or else through consciously adopted public policies. Major changes in wild land use practically never just happen.

What will be the impact of 60 million more people in another twenty years on the use pattern of our nation's wild lands?

Some of these wild lands are commercial timber producing acres. These are some of the acres to which we must look as the source of an increasing flow of greatly needed forest products. The per capita trend in lumber and paper consumption shows a long-term rise, a trend that probably will continue. Even if this trend were to just level out, as long as our population boom continues, total requirements for forest products must inevitably increase. The Timber Resource Review points out that by the year 2000 our needs for these products will probably be up about 90% above the mid-century requirements. Regardless of the precise figure, this estimate is highly significant because it clearly shows that economic forces alone will keep most of our commercial forest lands of all size classes and all ownerships straining to provide the forest products our expanding economy will have to have.

Some of these wild land acres are federal, state and county parks and monuments. Virtually all of these areas were established so that their lands might be devoted to certain specified uses, often to the exclusion of other uses for which the land in its natural state would be suitable. The significance for the future in this situation consists not so much in the uses that are provided for as in the uses that are precluded.

Also significant is the heavy use the established park areas are receiving now, and the universal concern of park administrators that existing facilities are inadequate for present population numbers, much less those of future years. Yet a great variety of future outdoor recreation needs for a 300 million plus population must be provided for. We as a people must figure out ways to do it. And we must do so while maintaining a pattern of land use that recognizes a need for wilderness areas, for wildlife areas, for livestock grazing and, in some places, for special watershed areas.

This is basically a wildlife conference. We in attendance here share an interest in wildlife problems. How are we going to meet the wildlife demands of a population that increases by 30 million people every ten years? What will be the hunting demand 20 years from now? What will be the fishing pressure? How will land managers and biologists supply the fish, and birds, and animals that will be needed? We cannot do it entirely by setting aside for this restricted type of public use additional areas taken from our dwindling supply of wild lands. We will have to manage so that fish and game are available for more people from acres that are already busy.

The livelihood of both wildlife and man depends on water. That is a separate subject this morning, which I am not going to open up now. But I cannot talk about wild lands, including non-timbered wild lands, without referring to water. Despite our engineering structures, and despite the hope that an economic means will be developed to convert salt water to fresh, the fact remains that precipitation is still our water source. And rain and snow make their first contact with earth on a watershed.

What man does to a watershed provides his first opportunity to exercise some control over water that falls from the sky. We will continue to need impoundment reservoirs and the other structures that manipulate a stream after it is formed. But I am convinced that we will always be fighting from behind in solving water problems until we are able to manipulate the cover and control the soil of watershed lands to make those lands serve their most effective watershed function. And this must be done while the wild watershed lands continue to be productive of game, recreation, timber, stock grazing, and the other outdoor uses I have been discussing.

Nor are these all the demands our wild lands will be called upon to supply. Most coal and oil companies are in the land managing business whether they want to be or not. The atomic age requires that industry have access to underground mineral resources. And on and on this list could go.

I want you to see a picture of pressure on the land, heavy pressure, growing pressure. This is pressure on wild lands. And it will grow rapidly as our population climbs. Most of us can visualize the way pressures come to agricultural land. It is much harder to picture pressure on wild lands. It is also harder to shape public policies so as to meet or channel pressures that come to wild land.

It seems to me self-evident that the only way we as a people will be able to meet these future pressures on our wild lands will be to make many of these wild land acres do more than one job, serve more than one use. That, if you please, is "multiple use." I am convinced that future land pressures and problems will require that all publicly-owned wild lands, and perhaps some that are not in public ownership, be managed under a conscious multiple-use policy.

One of the principal opportunities for conservationists today is to make this concept of multiple-use land management come alive, to make it work as a way of resolving pressures on land, and to achieve public acceptance of this philosophy as having significant public meaning.

This is an old idea to many of you here. The term "multiple use" has been bandied about for years. Like the word "conservation," it has come to have various meanings to different groups of people. I think of multiple use as a philosophy of land management, not as a technique. It is a philosophy which recognizes simply that an acre of land, by the way it is managed, may be made to serve more than one purpose. And so may groups of acres.

This philosophy of management need not be applied in a stereotyped manner; indeed, it is best used in a flexible way. In some circumstances, multiple use may mean zoning of a formal kind. Here the parallel with urban zoning is very close. Zones may provide for one or more specified uses, or may exclude one or more such uses. The plan of management for the Boundary Waters Canoe Area within the Superior National Forest is a good example of the zoning principal formally applied as a means of coordinating uses which would otherwise be in conflict.

In other circumstances, multiple use may mean a conscious plan to manage a particular tract in such a way that half a dozen significant uses may be made of the lands within the tract. In still other circumstances, multiple use may mean dedicating an area to one dominant use, to the exclusion of other dominant uses, but with recognition of subordinate uses. A typical example of this would be a winter game range where the managers must give first priority to whatever measures the game species require. Then, having done so, they can also give conscious management attention to keeping streams in the area suitable for fishing, and also to providing facilities for summer recreation use by campers and hikers.

There is a school of thought which holds that multiple-use management means the setting aside of many areas, each to be devoted to a particular dominant use. This practice would, of necessity, apply largely to public lands only. I will concede that there may be some special needs which can be provided for in no other way. A limited nesting area for a rare bird species may be an example. But I am sure that our wild resources will fall far short of meeting future needs if we rely only on this concept in the management of our public wild land resources. American ingenuity is capable of a more imaginative management outlook than this.

About here, someone might well ask the question, what about parks and wilderness areas? How can this idea of one acre doing the work of two apply to these areas? Isn't each park and wilderness area established for a particular purpose, and doesn't it then follow that each such area has a dominant use to the virtual exclusion of other uses? Let me answer that question by asking another. Do we want our parks and wilderness areas to erode away (disregarding geologic erosion), or to become biological deserts simply for lack of some current management attention to game needs or required soil stabilization measures? They can be superb parks and wilderness areas and be useful for some other things too without jeopardizing the primary purpose. In fact, I believe the managers of parks and wilderness areas have a public obligation to not permit the development, for instance, of unnatural soil silting conditions which would be obviously harmful to adjacent water courses.

One of today's very real opportunities in conservation is for conservation supporters to reach substantial agreement about the way parks and, especially, wilderness areas will be managed. There now is substantial agreement that they are needed. The manager of one of these areas undertakes to maintain a very intangible thing, environment; yet he must do so by dealing with tangibles like trail maintenance standards, insect control methods, ways of dispersing users, and ways of maintaining good hydrologic conditions of soil. He also must concern himself with undesirable impacts on adjoining areas.

The more use these wilderness areas receive, the more critical will become the conflicts between these tangibles and the intangible thing called environment. I fear that some of our most difficult future multiple-use problems are likely to arise over phases of this very conflict. There will be need for some recognized channels to help those with differing points of view get their sights together.

Well, how do we go about making multiple-use management work? First by doing it; that is by trying the idea out, with deliberate variations. Next, by studying accomplishments and publicizing the results that have been achieved by the many public and some private land managing bodies that have been following this land management philosophy for years. And by debating the issues, especially as to priorities of use and how they may be determined, until there is developed a relatively cohesive body of thought that can be supported by both the technicians and the interested non-professionals. As pressures on the land mount, and as increasing numbers of people are able to identify their interest in the way wild land is managed, our natural tendency will be to emphasize differences rather than areas of agreement. Long-term public interest will be the loser unless conservationists are able to keep the emphasis on their areas of agreement.

Making the multiple-use philosophy work requires that the conservation professionals get busy to work out a correct technical body of knowledge for multiple-use questions as well as for single-use questions. Public interest requires that future multiple-use decisions be based on adequate technical knowledge rather than being made by the contending of pressure groups, or by default.

Making multiple-use work means gaining public recognition of resource problems and the need for their orderly solution within the framework of the multiple-use philosophy. There is widespread recognition now that broad conservation problems exist. But there is no such recognition of their scope, or their complexity, or their interrelationships. Here is one of the real challenges of the decade.

Making multiple-use work also means arousing the enlightened interest of policy making officials, especially of elected public officials. Few professionals in the conservation field, and not many more of the lay enthusiasts, are in the right position to make the public policy decisions that future years will require. An acute need exists for county, town, and city policy making officials, as well as state and federal leaders, to concern themselves with understanding the complex problems this field presents. In what other way can the needed range of informed attention be given to critical resource problems in our expanding economy?

Conservation professionals are going to have to work at developing ways by which their knowledge can be passed on to managers of wild land, both public and private. For public lands and for many wildlife problems, there are cooperative approaches between public agencies that have proven to be effective. As a forester though, I am keenly aware of the tremendous job entailed in trying to put across adequate technical knowledge in any one phase of conservation to the millions of persons owning small forest properties which can contribute something in addition to wood products.

Conservation professionals will also have to face up to the need that exists now for a workable means of exchanging information on successful solutions to multiple-use problems. Perhaps a periodic multiple-use forum sponsored by a group like the North American Wildlife Conference would be one effective answer. We tend to work in our own technical fields. We tend to exchange ideas only with others in our own profession. Making multiple-use work requires that we who are professionals in any of the phases of conservation have more than a casual knowledge of techniques and problems in all of the other phases. And further, we must be able to look at them as a whole and to see their interrelationships. Between us, foresters, biologists, soils men and all the rest, we must somehow, sometime provide better vehicles for our own expanding self-education.

To this already challenging list of conservation opportunities, I would add one other. That is the opportunity to strengthen existing programs of conservation education in our schools. Every person who meets my definition of a conservationist can put a shoulder to that wheel—to develop in the youngsters now growing up a responsible concern about the future relationship between natural resources and people.

DISCUSSION

MR. FERRIS [University of Illinois]: I would like to ask about the attitude of the large, private companies, such as the paper pulp companies, who own a great deal of forest land on multiple-use.

MR. GREELEY: Well, first, there are as many attitudes as there are companies. However, I can name several large land-owning lumber and pulp companies that have policies of inviting people to go hunting on their land, of actually spending company funds for the development of recreation facilities and camping spots, and that have gone to many extremes to arrange for gates to be opened during hunting season—so that people who have nothing to do with those lands can go in to hunt.

I know of one or two outfits who have employed recreational and wildlife specialists to add that additional knowhow to the management that goes into those lands.

MR. DAVID BROWER [Sierra Club, San Francisco]: I would like to ask this question—where should management stop in connection with some of our wild lands, or should it stop?

MR. GREELEY: I would be glad to have someone else answer that question. Of course, that all depends on what you have in mind. If you just want to fight a fire and do nothing else, then management should stop when you have put out all the fires. However, I assume that you are referring to management in reference to wilderness areas, and one of the first points that I would like to make is that before you can ever have a wilderness area you have to do some conscious managing to keep it that way.

MR. BROWER: All of you may have seen a statement recently made by a man from Texas—that we have very little wilderness left and that will probably go soon. When it does man will have cut himself off from the evolutionary force and, in a terrifying sense, will be on his own. I think that this is something that we need to bear in mind. In fact, we are even willing to let God answer it.

MR. LOREN RITTER [Minnesota State House of Representatives]: What effect will Senator Humphrey's wilderness bill have on forest and wildlife management in the wilderness areas in Minnesota?

MR. GREELEY: You have given me a difficult assignment. However, we have to be a little careful here because the bill that bears Senator Humphrey's name and on which hearings were held last June, has been the subject of a good deal of further discussion and argument. I have seen copies of subsequent prints of the bill—a committee print number one, which I first saw in December and the committee print number two, which I saw for the first time only about two weeks ago.

Now, specifically, both of those committee prints, with reference to the roadless areas within the Superior National Forest, would have, in my judgment, very little effect on the management of the timber resources in the parts of those wilderness areas now zoned for timber operations.

TODAY'S OPPORTUNITIES FOR CONSERVATION IN WATER DEVELOPMENTS

D. H. JANZEN

Director, Bureau of Sport Fisheries and Wildlife, U. S. Fish and Wildlife Service, Washington, D. C.

About a month ago this nation projected into the atmosphere its first satellite, "Explorer," a culmination of American scientific research in a most complex field. We are all justifiably proud of this accomplishment, one of the first tangible steps in the new field of space conquest, and we hope for the success of this new venture, the potentialities of which stagger the imagination. But while we are probing the limitless depths of space, let us not forget that our mother earth and the resources thereon are still the foundation on which the success of space conquest must rest. This foundation must remain sound, and our water resources, as used or misused, will play an indispensable part in keeping this foundation sound.

Today's opportunities for conservation in water development are just as exciting to scientists and engineers in the field of resource development as are space conquest opportunities to those working in that field. Converting salt water to fresh water, making rain fall where drouth would be expected, storing surplus water underground for future use, keeping water clean and usable for many purposes through control of pollution—these are just a few of the challenges that will test the best brains of our nation. And these challenges must be met. We are now told that the demand for water will double in the next twenty years, and already we are confronted with water shortage—serious water shortage in many sections of the country. There is shaping up a real race between water demand and water supply, a race we cannot lose. This is one race that must be so engineered that the supply of the right kind of water will always stay one step ahead of demand. So let's not let the beams from an artificial moon blind our eyes to today's opportunities to conserve, use wisely, and develop our water resources for the long pull ahead.

And now I would like to talk a little about coordination in the field of water development. Coordination is a badly overworked term in the Government's vocabulary, but I think we can all agree that we don't see enough of its application. In water development the coordinated approach is absolutely necessary—there can be no other approach if we are to satisfy the requirements of an ever increasing human population. Whether we want it for drinking, swimming, irrigation, navigation, hydroelectric power or just to float a duck, the same water must serve many purposes.

Water development projects of today and for the future must have as their objectives the serving of all water needs. Single purpose projects which ignore other needs are extravagant users of water, and our potential water supply does not have a margin for extravagance. We must get maximum public use out of all water developments if we are to meet all our needs. A good example of a resource whose needs have steadfastly been neglected in the mad race for water utilization and development is fish and wildlife—a resource in which this convention has a prime interest. Unless water use for fish and wildlife becomes a purpose of tomorrow's water development projects, much of this particular resource is going to end up stranded—high and dry. To date most gains to fish and wildlife from major water development projects have been by accident—or because of the persistence of those interested in the conservation of fish and wildlife—seldom by design resulting from original planning.

But maybe one should not be too critical of past water development programs which were single purpose in their objective. Ours is a new nation whose resources development planning has been primarily by forces which had single objectives in mind. Necessary authorizing legislation and subsequent planning has reflected this single-purpose thinking. This was not serious in the field of water development when the ratio between water resources and human demands was favorable, but that day is gone. Irrigation, hydroelectric power, navigation, agricultural drainage, industrial use, sewage disposal and other demands on water are daily becoming more competitive in their efforts to divide the remaining water resources between them. Fish and wildlife, which originally had exclusive use of all this water, must now make a determined bid to retain a share for its own survival.

For example, migratory fish whose very existence depends upon unobstructed passage from their spawning beds to the ocean and return now face dams which even with man's help they cannot surmount.

A friend of mine recently asked me why fish should not have as much consideration as barges in a navigation system. I think he had a point. Water is just as important to a fish as it is to a barge, but the laws of our land do a much better job protecting the right of a barge to unimpeded movement than they do a run of fish whose very existence depends upon the continuance of an unobstructed river system. There are various proven ways of transporting freight from one point to another or of producing electric power, but so far no one has successfully changed the life history of a salmon.

Now what can be done to give fish and wildlife a little better break in this mad scramble for water? We now have on the books a most important piece of federal legislation—the Coordination Act as amended in 1946. It has been of great help—without it we wouldn't have anything—in aiding the conservation departments of the 48 States and the Fish and Wildlife Service in reviewing water development projects and making recommendations which would help minimize or replace losses to fish and wildlife, but experience over the years has clearly shown that mitigation of losses is not enough. Enhancement or definite planning for fish and wildlife improvement must become a part of water resource development programs, and the present Coordination Act does not provide for that. Amendments have been proposed which would provide authority to plan for and construct project features designed to enhance and improve fish and wildlife. They would facilitate making fish and wildlife habitat improvement a *purpose* of federal water development projects. They would provide general authority, now lacking, for the acquisition of land specifically for fish and wildlife purposes by Federal construction agencies at federal water projects. The availability of land for fish and wildlife management purposes is, as we all know, the key to fish and wildlife conservation at many projects. They would make the Act apply to projects already authorized, providing they are not substantially completed. They would permit acceptance of land and fund donations for carrying out the purposes of the Act, provide for withdrawal of public lands for access to fishing waters and would simplify procedures for the States to assume management of lands on federal projects of particular value to the migratory bird program. Enactment of these legislative amendments should go a long way in providing one of the opportunities Fish and Wildlife needs in the field of water development.

Preservation of wetlands valuable to fish and aquatic types of wildlife is another opportunity we should not muff. The loss of wetlands to drainage during the past 15 years has been very substantial, and a solution to this serious problem is now a major project of many States and the Fish and Wildlife Service. This loss is occurring nationwide.

Better coordination of land and water-use programs of the various federal agencies would go a long way toward solving this problem. We do, however, definitely recognize that even complete coordination will not save enough wetlands in the long-range picture, and a positive program for wetlands preservation, expensive as it may be, is another opportunity that must not slip by. Some kind of incentive must be provided landowners which will result in their not draining small lakes and marshes essential to wildlife. In many cases public ownership of wetlands may be the only solution. We hope, however, to find other less costly methods that can be used in combination with land acquisition. Public ownership of the magnitude necessary to do a complete job has many disadvantages. But of one thing we can be sure—it is going to be an expensive program regardless of what methods are used. And even with an all-out program of wetland preservation, aquatic wildlife habitat will still lose ground.

This brings us to a field of opportunities that as yet has hardly been scratched, the opportunity to have research lead the way toward production of more fish and wildlife on less acres of water—a program of urgent importance and one which to date has not been given the attention it merits. It is one on which the Fish and Wildlife Service will concentrate more of its financial resources in the future.

And now to get away from fish and wildlife and talk a little about other opportunities in water development. The possibilities of changing sea water into fresh water offer exciting opportunities for the future. This could lead to limitless supplies of water for many areas, with all that would portend. But again, for most of the Nation we will still have to depend upon nature's converter—the sun, the clouds, and the rain that falls from them. Proper use of each raindrop from the time it strikes the hilltops until it finds its way to the ocean still presents the greatest opportunity of today.

Let's look at an opportunity which we have badly neglected—pollution control—one which affects every one of us. It doesn't make any difference how we may want to use water—it costs more to use it if it isn't the right kind of water. Whether it be improperly treated sewage, industrial waste, silt from our hillsides, or chemicals from spraying operations, any foreign material which finds its way into our system of lakes and rivers depreciates the value of that water for some other use—often making it unavailable for other use until reprocessed, a procedure that in most cases should be unnecessary. A situation that has no place in this day when our very standard of living depends on an adequate supply of the right kind of water.

Transporting water for domestic use hundreds of miles across mountains, as is now being done on the West Coast, would seem to be a very expensive proposition, which it is; but it is no more expensive than some of the elaborate filtration plants cities must now construct to make polluted water fit for human use. Why not keep the contamination out of the water in the first place? That is the question which has been asked by countless water users. Certainly one of the opportunities in the field of conservation water development lies in developing ways and means of keeping industrial waste and city sewage out of our natural water courses. This opportunity of cleaning up and keeping clean our lakes and rivers is one we cannot keep on muffing.

Along this same line and of equal importance in pollution control is the problem of doing a better job in keeping the soil from our hillsides out of our water courses. A fine program for soil erosion control was started during the early '30s and the rapid acceleration of soil wastage through erosion was slowed down. But a bird's eye view of our whitening hilltops and eroding slopes followed by muddy streams and short-lived farm ponds and reservoirs makes it only too clear that we still have a long way to go in this field.

New sources of water contamination unheard of only a few years ago present wonderful opportunities for preventing some of the mistakes of the past. Atomic wastes present such an intensely dangerous potential to man that great care has been taken by the Government and industry to keep this type of pollution under control. But another new type of pollution, the dangerous potentialities of which we are just beginning to see, lies in the field of chemistry with around a half billion pounds of toxicants of various types being annually broadcast over our nation for insect and weed control. Many of these are applied over broad areas and await only the next rain to wash them into the nearest water course. Enough evidence has already come to light to make it clear that this new industry presents a serious threat to fish and wildlife, and even man may not come out unscathed unless we immediately concentrate more research on just what these chemicals may do and are doing to all living creatures. The complexity of completely understanding the effects, both direct and indirect, of the large number of new chemicals appearing on the market every year makes this indeed a very difficult problem to solve. But the importance of these chemicals to agriculture and the variety of new uses being continually found for these chemicals makes it a foregone conclusion that more, rather than less, chemicals will be used in the future, and we have therefore no choice but to concentrate more research on this problem immediately.

I think that water pollution regardless of source generally will have to be brought under control. Man just is not going to be able to live with it. The combination of sewage, chemical, and silt contamination does such a thorough job of killing our streams and many lakes, both natural and man made, that the problem is brought into sharp focus. This coupled with our rapidly growing human population leaves only one recourse, clean up or clear out. A privy in the backyard presented no problem when the next-door neighbor was a quarter-mile away. But when your neighbor builds his home next door and sinks his well under your privy the situation becomes quite different—that is the situation facing us on a broad scale today.

There are a number of opportunities for water conservation in new untested fields. One of these involves the storage of water underground. Studies along this line are underway. The advantages are many. The surface soil over the underground reservoirs can be utilized and the loss through evaporation is negligible. Out of this study we may also learn that many of our wetlands so often termed waste lands by the uninformed may be very important in the recharging of the underground waters. More research into the relationship between surface and subsurface waters will be necessary to fully realize water development opportunities in this field. But the potentialities warrant more attention than has been given this type of water conservation in the past.

Weather control and its possibilities in producing more or less rainfall presents limitless and almost frightening opportunities. Let us just hope that while research is finding the answers on how to turn on and turn off the rain from the heavens, operations will move only as fast as prudence dictates, but this could be the biggest opportunity for water development of them all.

Opportunities for development in the field of water conservation are endless. But we must have the vision to see them, the determination to make use of them, and the intelligence to fully and properly exploit them.

In closing I would again like to repeat that space may be conquered by earthlings, but that earth will have to remain strong during the process. Without enough of the right kind of water this cannot be. We need only to look back into history to see what happened to nations who outgrew their water supply.

DISCUSSION

VICE-CHAIRMAN BUSH: The discussion this morning has served to emphasize for me, and I suppose for you, what we have known but what we so easily forget—and that is the unity in all these directions, especially in the philosophical basis that underlies it.

First we heard Mr. Williams discuss the interrelationship between agriculture and wildlife management, and then Mr. Greeley discussed multiple uses and philosophy and its importance in forestry and now we come, in a general discussion on water, to a sentence—''Whether we want it for drinking, swimming, irrigation, navigation, hydro-electric power or just anything else, about the same water must serve many purposes.'' All of these men have been talking about multiple use in fields so interrelated that it is difficult to separate one from the other.

There is another comment that I wish to make and that is that when Mr. Janzen compared water development and water studies to the Sputniks he was, I think, talking about something that is very fundamental, because we have all got ideas of going to the moon. However, going to the moon isn't going to feed anybody on this earth, it isn't going to irrigate any of our deserts, and it is not going to provide water for industry that industry so desperately needs in the coming decade. I think that what the gentleman has just been talking about is much more important than anything that Edward Teller ever talks about except when he discusses atomic energy as it applies to peaceful use. Thank you for the opportunity for that comment.

TODAY'S OPPORTUNITIES FOR CONSERVATION IN INDUSTRIAL DEVELOPMENTS

ED STOUT
Public Relations Officer, Bowaters Southern Paper Corporation, Calhoun, Tennessee

I am indeed happy to have the privilege of discussing with you the subject, "Today's Opportunities for Conservation in Industrial Developments." I say this because a look at the record reveals that progress in forest industry conservation presents one of the brightest spots in the natural resource picture in the United States today.

The forest industries have traveled a long way since the eras of "cut out and get out" and "pollute and plunder." Instead of butchering a great resource, the wood-using industry today is providing materials necessary for our way of life, and in ever increasing quantities, and at the same time contributing to the improvement of our forests, wildlife, soil, recreation and water resources.

Let's unwrap this package and take a closer look at what these facts promise for tomorrow.

This conference cannot profit from a re-examination of the sad unfortunate early-day history of our wood using industries. You and I know that story. A rehash of old troubles is too much like trying to make birth control retroactive.

Yet history is like a surveyor's transit. Unless we use it from time to time to look back and get our bearing it will not be of much help to us in running a straight line ahead.

During this century the United States Forest Service has made a number of inventories of our forest resources. All of the early surveys disclosed we were using and wasting more wood than we were growing.

Naturally many citizens believed we would run out of wood. You and I remember the "timber famine" talk. Even the chief foresters of the United States for many, many years advocated government regulation of timber cuttings on privately owned lands.

The latest U. S. Forest Service inventory, however, shows that for the first time in our lifetimes the forests of our nation are growing more wood than we are using.

Here is our wood supply situation at a glance:

—Trends in forestry assure increasing wood supplies in the future.

—We are improving wood quality and speeding timber growth.

—Protection against fire, insects and disease is becoming more effective.

—More and more privately owned forest land is being put under sound management.

—Forest industries are finding uses for all kinds of trees and for all parts of trees.

This awakened stewardship of land goes beyond the growing of wood. Although the forest products industries own only about 13 per cent of the commerical forest area of the United States, they have opened at least 42 million acres to the general public for recreation, hunting and fishing! That is a most encouraging entry on our natural resource ledger, especially in this day and time when there is such widespread concern over where we will find a place to hunt and spread a picnic.

Credit for the discovery that forest industries are making available at least 42 million acres of land for hunting, fishing and recreation belongs to an organization called American Forest Products Industries. This is an association financed by pulp and paper, lumber and plywood companies. The organization uses educational projects to promote the growing of more trees and nationally sponsors the Keep Green campaign for forest fire prevention and the Tree Farm system for recognizing and spreading wise management of forest lands.

Mindful that its Tree Farm program encourages certified landowners to "utilize their timberlands for recreational, watershed and wildlife purposes," AFPI conducted a survey among its members to determine to what extent the forest products companies practiced what they preached. Here is a brief resume of that survey:

—455 companies responded.

—46 million acres were covered in the response (that is only about 75 per cent of the total acreage owned by forest industries).

—38 million acres are open to camping.

—45 million acres are open to hunting and fishing.

—14 per cent of the responding companies operate public parks, and more than 20 per cent are planning additional parks.

Another most encouraging revelation came from the AFPI survey. It is this. Thirty-eight companies are employing recreation planners and game management specialists, and that trend appears to be growing fast. To this we must add the fact that today there are more graduate foresters in private work than in state and federal agencies combined, and many of these men received wildlife management training while earning their forestry degrees.

Wood using industries also are making significant contributions to our water resources.

Take the matter of reforestation. Billions of man-planted trees are covering what was once bare and burned land. These trees are providing wildlife habitat on much land which formerly was almost a biological desert. Think, too, what these trees are doing to slow down stream sedimentation. Tree planting has doubled and redoubled, again and again, even before the Soil Bank.

There is refreshing news, too, on the stream pollution front. In this arena the pulp and paper mills for years wore the bloody noses. Today this industry is holding its head high, and justly so. Look at the record.

During the past 10 years the industry has spent $85 million dollars on the construction of waste treatment facilities. And better use is made of water. For example, where bleached kraft pulp production in 1925 required 175,000 gallons of water per ton it is now accomplished with as little as 40,000 gallons. Even more important, the pollution load per average ton of pulp and paper is now less than half the amount of 10 years ago.

Pollution control is carried out by the pulp and paper industry through an organization called the National Council for Stream Improvement. This association, formed in 1943 and financed by more than 200 companies, is dedicated solely to fulfilling the responsibility of a responsible industry towards a priceless gift of Nature, the rivers of America.

The National Council coordinates the research of its member companies. In addition, it sponsors research at more than a dozen of our colleges and universities.

Thus, in a relatively brief period the forest industries of the United States have switched from the role of a destroyer to that of a developer of natural resources. Although not quite ready for a halo, the modern day "timber baron" certainly doesn't wear a red suit and tail, and carry a pitch fork.

Next, let us examine what brought about this progress. Certainly laws are not responsible. Legislation rarely provides the answer when economics and the character of men are involved. Someone has figured out that we have 35 million laws trying to enforce the Ten Commandants.

The turning point in forest conservation came about when supply and demand made trees growing practical, and profitable, for landowners. This rule applies to the companies, too, plus the fact there has unfolded within the industry a realization that in the field of natural resources, where countless conflicts arise, sound business calls for an understanding of the point of view of others. Call it public relations, if you like. Good business and good will go hand in hand.

Public relations, however, is a two way street. And here is today's greatest opportunity for you to contribute to even more industrial conservation progress.

Better understanding between you and forest industries will help insure that the millions of acres of company Tree Farms now available for hunting, fishing and recreation, will forever remain open. Better understanding should bring about the opening of additional acres to the public.

Here are a few tips on how you can help:

Fire continues to be a serious threat to our forest lands. The average is nearly 500 fires daily. These fires annually burn an area about the size of Massachusetts, Connecticut and Rhode Island combined. Just the cost of fighting nearly 150,000 fires comes to more than 70 million dollars a year. All conservation agencies must shoulder part of the responsibility for this continuing, shameful waste.

There is another way you can contribute to improved relationships with large Tree Farm owners.

As you know, many wild animals are destructive to forest growth and too often relief comes too slowly because game management legislation in many instances fails to keep up with the changing times. The forest industry lands survey, conducted by American Forest Products Industries, reveals:

—Owners of 20,000,000 acres reported damage by deer. Owners of 13,000,000 acres classed this damage as serious.

—Owners of 13,000,000 acres reported damage by beaver.

—Owners of 9,000,000 acres reported damage by bear.

When overpopulation of game threatens full production of tree crops, swift action is in order. In this respect you can serve the cause of better game management *and* better forestry.

One other suggestion for improving relationships:

Those of us interested in the production of wildlife and recreation—on lands owned by others—must keep in mind the basic reason why corporations own land. Forest products companies own land to grow crops of wood. That purpose alone justifies the investment of the stockholders money in millions of acres of real estate. We must not lose sight of the fact that the management of corporations has first priority responsibility to employees and to the owners of the company—widows, retired couples, school teachers, bankers, businessmen, working men, and all the others who are stockholders.

You and I know this. But we do need to pass such a reminder along from time to time to some of our more vocal, and less objective, fellow outdoorsmen.

All of us concerned with the broad field of conservation realize that conflicts of interests do exist. Solutions to most problems, however, will come easily and successfully if we will take the trouble to understand the other viewpoint.

One of the difficulties we face is that few controversies have only two sides. We have always heard, of course, that every question has two sides, but life is too complex for that approach to hold true very often. Our language tends to force us into a "yes" or "no" position. We are brought up to think in opposites such as clean or dirty, long or short, true or false, good or bad, black or white. Whenever we force a problem into a rigid pattern of black or white, when actually there are various shades of gray, we create a serious roadblock to straight thinking.

Take the case of automobile drivers. One school of thought says, "Women are bad drivers." The other contends "They are better drivers than men." The facts indicate then in some respects women are better drivers than men, in others, worse. Women crumple more fenders, but mile for mile have fewer accidents involving fatal injury.

Besides unsound opinions, lack of communication has been another roadblock to closer conservation cooperation. Too often foresters have been guilty of shooting from the hip and declaring, "A hunter did it," without bothering to obtain the other side of the story. On the other hand managers of pulp mills have learned first through newspapers that they are faced with new stream pollution accusations.

This is what is sometimes called the "shoot first and ask questions later" approach. It is a practice which does not generate clear thinking, mutual understanding and close cooperation. Even the climate for later compromise is damaged.

But this is changing. More and more foresters are attending meetings of wildlife organizations. There is a trend, too, whereby conservationists take their problems—not to the press—but first to the chief foresters and general managers of any forest products industries which might be concerned.

With the outlook for our wood supply much brighter than ever before, industry foresters are finding more time to devote to the cousins of forestry—wildlife, fishing, camping and other recreation fields. We have before us today all of the ingredients for a true partnership for progress.

DISCUSSION

VICE CHAIRMAN BUSH: Mr. Stout, it is encouraging to all of us to be reminded again of the splendid progress and tremendous achievements being made by the wood industry of America.

MR. J. C. McCLELLAN [American Forest Products Industry]: I thought that you might be interested in the survey that Mr. Stout referred to. That survey was conducted after a nationwide public opinion survey which revealed that most of the people of the United States thought that cutting was destructive to wildlife and that most industry lands were closed to hunting. Therefore, we ran that survey in response to that thinking.

VICE CHAIRMAN BUSH: Thank you very much.

I wonder if Mr. Stout or someone else here this morning could tell us what some of the other major industries in America might be doing toward the proper conservation and utilization of the land resources in their areas? Would you like to comment on that, Mr. Stout, or is it too far removed?

MR. STOUT: I do not feel qualified.

VICE CHAIRMAN BUSH: I think we have noticed, for instance, that the Sinclair Oil Company has run a series of conservation ads in a number of magazines. Certainly other large companies must be doing some constructive things.

MR. SETH MEYERS [Pennsylvania]: We have a lot of publications by many industries and I recommend them to those people who do not believe that industry is conscious of the need. Of course, these are house organs and publications for their employees, and more and more the steel industry and other industries are becoming conscious of the need to acquaint all of their employees, along with management, of the need for conservation measures.

There are many industries and companies who are acquainting their employees and the readers of their publications with conservation facts.

VICE CHAIRMAN BUSH: Thank you, it is good to know that. There is one question that I would like to ask Mr. Stout. He spoke of $85 million having been spent on anti-pollution measures. I wonder what estimate there was of how much yet remained to be spent before the job could be done and what plans there were to continue this program?

MR. STOUT: This, of course, is a continuing activity and I have not yet heard how much will ultimately be spent. Part of this has been expenditures for additional equipment and, in the case of the pulp and paper mills, this pushes up the cost of the paper and so there is a question as to how much we can pay at this time. However, I think it is encouraging that such a vast amount of research is going on. The findings of the research projects at the various colleges will be applied by the industry from time to time in an increasing fashion.

CONSERVATION IN URBAN DEVELOPMENT

ELDRIDGE LOVELACE

Partner, Harland Bartholomew Associates, St. Louis, Missouri

I was most pleasantly surprised to find a concern with *urban areas* on the part of people interested in wildlife and wildlife management. My first thought was that those of you in charge of the program, from a reading of your newspapers, had come to the conclusion that there was more wildlife within the cities than outside of them and that it was high time attention was given to this aspect of the subject. However, this trend of thought did not seem to fit in very well with the idea of "conservation."

Then I remembered a monumental report prepared in 1937 by the National Resources Committee and entitled "Our Cities—Their Role in the National Economy." The cover of this report consisted of a map of the United States on which were a great number of dots, the area of each dot being in proportion to a city's population and each dot being located on the city's site. Naturally enough the cover suggested a new title for the report which was, "Our Cities—the Blots on the Nation's Landscape."

It is these cities, these "blots on the landscape" that I am to discuss this morning in relation to conservation. When we think of conservation many of us think of the land; the city planner thinks primarily of land use or of putting the land to its best and most useful purpose.

URBAN LAND USE IN THE NATION

In the beginning it might be well to take a brief look at some over-all quantities. In 1950 the United States had a population of some 151,000,000 persons and of this 97 million or 64 per cent were classified as "urban." Based upon land use surveys our office has made of a number of metropolitan areas we would estimate that this urban population actually used some 22,500 square miles of land area for urban purposes — that is for all residential, commercial, industrial, public, institutional, streets, and other actual urban uses. This, however, was only eight-tenths of one percent of the nation's land area.

Fifty years earlier—in 1900—the urban population of 30 million persons was only two-fifths of the nation's total of 76 million. The total urban area occupied was probably in the vicinity of only 3500 square miles. Thus in fifty years the urban population tripled while the land area occupied increased six times.

We all know too well that these trends are increasing at an expanding rate. The nation is growing very rapidly; the growth is almost entirely in urban areas. Of great significance also is the changed character of urban growth with ever larger areas used for every urban purpose. Our major streets and highways have rights-of-way of 200 to 300 feet instead of 80 or 100 feet. The one-story, single-family home on the larger and larger lot, the shopping center with parking areas measured by the acre, the industry with a site of half a square mile are common and typical phenomena. More and more people are using more and more land for urban purposes.

By the year 2000 our nation's population is likely to reach 275,000,000 persons with 85 per cent being urban in character. The per capita use of urban land will at least double during the period from 1950 to 2000 and the 235 million urban inhabitants of the year 2000 may require as much as 82,000 square miles of urban land area. Even so this will be only 2.8 per cent of the land area of the United States. However, this area becomes more significant when related to the total area in cropland. In 1950 the total area in cropland was 640,000 square miles or a little over 21 per cent of the nation's area, while the area in Class I farmland which produces 20 per cent of crop values amounted to 3.8 per cent of our total land area.

Thus from the very limited standpoint of land area occupied alone, the urban uses are becoming significant.

In England we have seen the conflict between urban uses and a very limited land area available for agriculture and have watched with more or less academic interest the efforts of the British Government to eliminate this conflict, never dreaming with our vast land area that we should see such a conflict here. Instances of it are beginning to arise in such places as the San Francisco Bay region in California where subdivisions are pre-empting excellent agricultural lands. This is also happening in Hawaii which has a most limited usable land area. In several cities including Louisville and St. Louis excellent land for truck gardening has been subdivided and probably unnecessarily. On the fringes of many of our metropolitan areas provision of schools alone for a few new subdivisions has so raised the local tax rate that agricultural use is becoming uneconomic. Thus we too as a nation will have conflicts between urban uses and other uses and will want to look again at some of the British practices. Perhaps we can profit by their experience and take action before it is too late.

FORM OF THE URBAN AREA

The haphazard spilling-out of our urban areas over the countryside with no form or pattern and no seeming sense or reason unquestionably is the most disturbing, or most frightening, aspect of our present day urban development. All of the experts on urban growth are unanimous in decrying this condition which they term the "urban sprawl." Only the fact that I am at home—not away from home—today and thus cannot qualify as an expert prevents me from joining them in this universal "viewing with alarm."

In Colonial times the urban area was circumscribed by the distance a man could walk—or ride a horse and buggy. Williamsburg and Charleston, South Carolina, are examples of this period. Then as the nineteenth century moved on transportation improvements occurred. St. Louis from where we are now to its city limits is a good example of the "street car city" occupying, generally, a radius of about five miles. This current century brought the automobile and an almost measureless area of urbanization. There is suburbia and then exurbia. It is not unusual to live 20 or 25 miles "out." But then a major industry or commercial establishment such as the Monsanto Chemical Company here in St. Louis may move 10 to 20 miles away from the downtown area and its worker may then move 20 to 30 miles beyond that. Where it will all end, no one knows.

Any tie to a public transportation system seems most tenuous insofar as our urban areas are concerned. The automobile has taken over almost completely. In most cases, however, urban commercial, industrial, and residential land uses do need public water and public sewers and, upon examination, the "urban sprawl" can be found tied together by a network of cast iron and ceramic pipes. In certain instances a combination of geology, topography, and intelligent urban planning and administration is bringing about urban areas with sensible and coherent forms. It must be admitted, however, that these are the exception, not the rule. Urban sprawl is the rule.

Within the foreseeable future urban development will no doubt be freed of the bonds of the public water and sewer systems. Already individual sewage disposal devices are being perfected. Individual water supply may be a more troublesome problem but with new power sources available it will be solved also. Then there will be no natural control over the form of the urban area whatsoever and all that will be left will be any arbitrary control exercised by planning and zoning agencies. Experience to date would not indicate that these would be too successful in such a drastic control, even though such control is needed and fully justified.

What will our urban areas look like if there is neither natural nor artificial control over their basic pattern?

During the last three years our office has been undertaking planning studies for several communities in the southwestern part of the

State of Michigan. Here, a sandy soil—perfect for septic tanks—and a high water table have made public water and sewer systems almost unnecessary. From an inspection of this area we can perhaps foresee the form of the future urban area—city, or community.

In this general region in Michigan any line between "urban" and "rural" has disappeared. New industries are found in rural areas. Residential uses of an urban character are found here and there along almost all of the rural roads. I doubt that there is a single farm family that does not receive a significant portion of its family income from urban employment by one or more members of the family. Seemingly rural townships have doubled or tripled in population in the past ten years. The suburban or exurban growth has gone so far that many cities have given up any attempt to extend city limits to keep up with it. While cities are growing too, they are growing much more slowly than the total community.

In this instance and from the inside looking out, the "urban sprawl" does not look half bad. In fact it looks pretty good. Planning and zoning measures are essential primarily to keep commercial uses, billboards and junk yards from scattering up and down all of the highways, and to insure an adequate character of residential use—to keep a few substandard houses or shacks from spoiling several square miles of countryside. These troublesome occurrences are frequent; most were located before the rural township governments caught on to what was happening.

To the new home owner locating in a rural or semi-rural part of this region there are significant advantages. These are important because they influence more families who seek the same thing. Families in such areas have plenty of light and air around their homes, large lots, associations with nature; they may raise animals or grow a large garden. They have a local—close to home—government on a school district or township basis, and reasonable taxes, particularly if a big new industry locates in their school district or township. Of course, public services are poor or missing and insurance rates are high but no family seems to mind that.

A complete dispersion of all our urban areas along the lines of the southwest Michigan prototype is not likely for many decades, perhaps another century. Some experts have predicted that the next two or three decades will see some 14 gigantic strip cities that will contain 80 per cent of our population. It would appear far more probable, however, that the result will be so great a dispersion as to cause the words "urban" and "rural," "city" and "country" to have but little difference in meaning so that no one may ever know—or care—whether the 14 strip cities come into existence or not!

What will happen to our present urban areas in the future? The newer parts built at a low density with due regard for amenity and open space no doubt will remain because their amortized price and value will be competitive with new construction. Other parts, particularly those built at an abnormally high density such as the new public housing in St. Louis, and some of our intensively developed urban renewal projects, for example, will probably be cast aside and abandoned. The face of the globe carries the scars of many abandoned cities from other civilizations; there is no reason to suppose that some of ours will not suffer the same fate; certainly it will be a well deserved end for many of them. The cost of abandoning significant parts of our urban areas is not a severe obstacle; we could buy up and turn into farm land 1000 square miles per year of fully developed urban property for the amount we spend on national defense. If our urban areas do not measure up to our needs we will abandon them and cost will not stand in our way.

CONSERVATION WITHIN THE URBAN AREA

Let us turn now to a more detailed consideration of conservation within the urban area itself. Our cities furnish some inspiring examples of conservation, such as Rock Creek Park and the other parks in the District of Columbia, the mountain parks of Denver, the magnificent park system of Kansas City, Missouri, with its preservation of scenic values of bluffs and valleys, Stanley Park in Vancouver, the parks of Minneapolis—the list is almost endless.

Park systems that preserve areas of scenic interest, stream valleys, etc., are, of course, the most dramatic examples of urban conservation. Others that can be mentioned include the planting of trees, particularly street trees (most of our cities appear to be a forest from the air) and the large lot single-family residential subdivision that has been carefully adjusted to the topography. In some of these latter developments close in to the center of the city we frequently find numerous song birds, quail and sometimes pheasant, lots of rabbits and squirrels and occasionally a skunk or raccoon. Presence of such wildlife can be considered pretty much a seal of approval for the designer of such a subdivision development.

On the other side of the picture, the bulldozer probably symbolizes the negative aspect of urban conservation. To most developers the first step in any project apparently is to (1) cut down all the trees, and (2) flatten the land as much as possible, preferably burying the topsoil under 10 feet or so of clay in the process. Housing projects and subdivisions resulting from this process have a bare and forlorn appearance for decades despite the fact that untold fortunes are spent on grass seed and fertilizer.

To save trees and fit a design into the natural landscape requires careful attention and much survey and design work on the part of landscape architects who know their business. While their fees may be high, investigation of a few examples convinces us that this cost is not nearly as much as that of the bulldozer operator and the bulldozer approach to this problem. The result, of course, when you design *with* the land is a development far more pleasant to live in and much more valuable.

Nor is the principle limited to residential subdivisions. Saving of native plant material and fitting of designs to topography are essential to commercial and industrial areas also and virtually indispensable to public and institutional facilities.

A final example on the negative side of urban conservation is the use of land for intensive urban purposes in flood plains of rivers. Expensive flood control works could have been avoided in some cases by proper zoning of the flood plain.

MEASURES REQUIRED TO IMPROVE URBAN CONSERVATION

In general there are three measures needed for improved urban development, or urban conservation.

1. *Planning and Zoning*

While the growth of city planning and zoning has been rapid, it is constantly falling behind in its attempt to keep up with the tremendously dynamic urban growth groblems. Our planning and zoning is least effective in dealing with the most vital problem—growth and development of the urban fringe areas. We know that well drafted and enforced planning and zoning measures can be effective in guiding new urban growth before it occurs but quite frustrating instruments to correct mistakes after they have been made. It is the rural areas, the counties and the townships, where our planning and zoning efforts should be concentrated. Every county in the United States should have been zoned at least 15 years ago; yet it is estimated that not more than 200 out of the 3100 counties in the nation (6 per cent) are zoned today. In some that are zoned the quality of the regulations leaves much to be desired. Furthermore, 1900 of our counties could not enact zoning regulations even if they wanted to; state enabling legislation is lacking.

The counties and townships that do not have good zoning regulations in effect 10 years from now will probably be too late to do much more than reap the sad harvest of the urban hodge-podge within their borders.

We need more and better regional planning also. City limits are meaningless today and will be absurd tomorrow as a planning boundary. Every state should have legislation providing for effective *regional* planning similar to that recently enacted by Oklahoma and Indiana.

The local city, county or township cannot be expected to do a good job of planning or zoning without being able to relate its plans to the larger region of which it is but a part. Nor can these larger regions do a good job without relating their work to state and national consideration. We desperately need thorough and effective planning at the state and national levels for such matters as land use, water resources, economic trends and the like. The territorial planning now being undertaken by Hawaii is perhaps the first example of the type of broad scale planning that is needed.

2. *Fitting Development Plans to the Land*

Both encouragement and local legislation are required to bring about land development more suited to the topography. A recent ordinance of the Village of Blue Ash, Ohio, for example, prohibits subdividers from destroying any tree with a caliper of four inches or more unless it is within a roadway, driveway or actual building site. Interest of garden clubs in such matters is heartening but far more needs to be done. We should all fuss, complain, write letters to the papers, and talk to anyone that will listen to us until cruelty to the land becomes as offensive as cruelty to animals.

3. *More Public Land*

Finally, one of our biggest troubles is that all of our local governmental agencies are "land poor." In all of our communities we need to preserve great acreages of land for green belts, for forest preserves, or for what may be a far more valuable long range use for agriculture. There is no reason why we cannot use the device of purchasing development rights to much of this property, thus insuring a proper future land use. Our vastly increased urban population will require many more parks, reservations, forest preserves, lakes, beaches, etc. Good land use in the semi-urban, semi-rural community of tomorrow will require a revision in our concept of public land ownership. In essence this will be an expansion of the type of activity being undertaken so successfully by several Illinois County Forest Preserve Districts today.

CONCLUSION

Urban development of the future should tend to more and more fit itself into, if not disappear into the natural landscape. The blots on the landscape perhaps will fade away. In new city building, new urban development, we might well find guidance as well as inspiration in the following words of Albert Schweitzer:

> "The great fault of ethics hitherto has been that they believed themselves to have to deal only with the relations of man to man. In reality, however, the question is what is his attiude to the world and all life that comes within his reach? A man is ethical only when life, as such, is sacred to him, that of plants and animals as that of his fellow man, and when he devotes himself helpfully to all life that is in need of help."

DISCUSSION

VICE CHAIRMAN BUSH: It seems, in a sense, almost bad to say anything after what I conclude to be an excellent statement of philosophy which, in a sense, undergirds all of our conservation efforts.

MR. SIEGELSON: I was on a program last week in Washington and we discussed some of the things you mentioned. As a result of that discussion, the question came up which nobody seemingly could answer. Therefore, I would be very interested in getting your personal answer to this question.

You stated that we have ten years in which to pick up all the needed recreational and park lands in our urban areas. The cities, in the present situation, do not have strong committees and do not follow plans to acquire necessary areas which we have in almost all states of the Union. Our cities are getting somewhere as the background of this whole business to prepare the public for the gigantic acquisition program. We all agreed that there was no time for education, in view of the swiftness of these developments.

Therefore, if there is no time for education, how in your opinion, can we, swiftly and dynamically, do these things while there is still time? Is it a matter of setting up a Federal Study Commission to create public desires, to enable the government to move swiftly while there is time—or what is the answer?

MR. LOVELACE: First of all, I would disagree that there is no time for education. I think that a lot of the education has been done. It needs a little better focus. There are examples of where, in some places, attention of the local community was called to what needed to be done, and they have gone ahead and done it. We had a bond issue passed recently in a Texas city by a two-to-one majority to spend almost a million dollars on a park system.

What is needed is more dynamic leadership on the part of the conservation people—the garden clubs and interests of that type—to bring about specific plans and projects and get them before the voters. In nearly three-quarters of the cases the education is sufficient so that the voters will provide the money and go ahead and get the job done. The thing that we seem to lack is leadership to pull this together, to sell it, and get started. I would say that the crux of the problem is leadership.

You need attention at both levels, both from the standpoint of the over-all national problem and from the standpoint of developing effective local leadership because, to me, these are problems that have to be solved locally. The only thing that you can do nationally is to call attention to the national problem.

MR. OLDS [Michigan]: I wonder if a tool or device known as the Plat Act has been utilized to the fullest extent in controlling sub-division of land and to what extent the states have utilized that tool in this field?

MR. LOVELACE: The difficulty in all of our urban developments is frequently that we are prone to say that we cannot do anything about this because the state legislature will not give us the power. That, in my opinion, is just an excuse—not a reason. The state legislatures have given the majority of our states more than adequate legislation to control subdividing of the land under the Plat Act, which we have in almost all states of the Union. Our cities are getting somewhere between 10 and 25 per cent of the potential value they could out of a properly enforced and adequately administered land subdivision control. Our efforts along that line could certainly be strengthened. It is not anything that we need money for. It is something that we could start doing a better job on tomorrow.

MRS. WEBSTER [Missouri]: I think the fact that you are recognizing the garden clubs and the women's organizations means a great deal. If you let them know that you have faith in them then they will go to bat for you in all of these things.

VICE-CHAIRMAN BUSH: Thank you very much, Mr. Lovelace, and also thank you, people, for your cooperation and your questions and your comments this morning. I think the chairman has a word.

CHAIRMAN MORRIS: I should like to call attention to the excellent relationship that exists following through the theme of this conference. Here, of course, I have reference to the other two general conferences still to come. All of the themes of these three conferences are closely woven together.

In relation to this program today, I should like to express appreciation to the busy and distinguished people who have taken time to prepare for us these thoughtful and careful presentations that have been made here.

So far as organization of the program is concerned, as Chairman of this program, if I were to react again to the question that has to always be asked in the initial formulation of a program—what should be done that was not done—what should be added that is not here—I am very clear in my own mind of something that should have been a part of this program today which was not and, of course, I mention it for two reasons—first, to express an awareness of it and clear my own conscience as it were and, secondly, to leave it as a suggestion for future programming.

It seems to me that we have overlooked in this program today that most of the wealth of the nation is controlled by the women and, indirectly, almost all of it. Therefore, if we really want something done in the way of preventing things like stream pollution, then we ought to get the women and the women's groups in on the activity. We need not only the garden clubs but also the other women's groups and professional organizations. If we could do this we would move forward materially both in the long-term and short-term sense, because here is the source of real education and here, as well, is the motivating force.

GENERAL SESSIONS

Tuesday Afternoon—March 4

Chairman: IRVING FIEST
Chairman, National Conservation Committee, Boy Scouts of America, Newark, New Jersey

Vice-Chairman: H. WAYNE PRITCHARD
Executive Secretary, Soil Conservation Society of America, Des Moines, Iowa

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YOUTH AND OUR NATURAL RESOURCES

REMARKS OF THE CHAIRMAN

IRVING FIEST

It is a privilege and a pleasure to serve as Chairman of this session. Before starting I believe that it is fitting and proper, as a layman aware of the importance of both youth and conservation to our national well being and the future of our great country, that I try to pay tribute to the officers, the board and members of the Program Committee of the Wildlife Management Institute for producing this most constructive and comprehensive program each year. A special vote of thanks should go to President Ira Gabrielson, Mr. C. R. Gutermuth and the staff for the yeoman job of organizing this great meeting.

The National Wildlife Federation consists of three million sportsmen and conservationists, including thousands of young people. It is making three million Americans aware of the great national wealth in our natural resources and of the need of caring for and protecting those resources. We must preserve our heritage of nature.

In whose hands can this work best be left? First, let us train our youth in true appreciation of nature and her many gifts. This is the work that the Boy Scouts, the 4-H Clubs and the Future Farmers are doing so well and which is the challenge to every other organization and individual in our country.

This year, as you all know, our theme is "Conservation in an Expanding Economy" and many facets of this problem have already been discussed. However, as many of you know, these are never problems, but they are always opportunities and so it will be that in connection with our subject of today that you will hear from experienced leaders in conservation, men who have made a profession of serving youth—scientists in conservation, educators, men who have dedicated their lives to character building, to citizenship training, to the service of youth and to conserving the natural resources of our nation.

Conservation of our natural resources—soil, water, minerals, forests, range land, fish and wildlife—even today becomes a more important part of citizenship training of young people of America. The political, military and economic crises throughout the world emphasize the fact that the wise use of our resources is tremendously important in the future of a free world. It has been pointed out that the physical strength of America depends upon its natural resources. Our ability to remain free and keep America strong, as well as our ability to help restore freedom around the world depends upon using our resources productively.

Equally important are the human values stemming from our natural beauty areas—parks, monuments and recreational facilities—where millions of Americans gain spiritual and physical health each year.

SCIENCE AND RESOURCES IN AMERICA

CLARENCE COTTAM
Director, Welder Wildlife Foundation, Sinton, Texas

I am honored at the invitation to participate in this the second general session of this great Conference whose central theme is "Conservation in an Expanding Economy." We do have an expanding economy, and if it is to endure, and particularly if it is to continue to expand, we as a people must not only preach but practice conservation. No aspect of this broad subject is more important nor more timely than the central theme of this session—Youth and Our Natural Resources. As a prelude to this, I am assigned the topic of Science and Resources in America. I should like to address my discussion primarily to the point of view of youth and the impact we need to make on them.

VALUE OF AMERICAN RESOURCES

It is time we start getting the idea over to the rising generation that America's wealth, economic security and greatness cannot be measured by the extent of its reserve gold or silver bullion nor by the amount of currency in circulation. These are merely media of exchange. The real wealth, in addition to the character, quality and health of our people, is the abundance and variety of our natural resources. It shouldn't be too hard to show our young people that a nation is rich only so long as its supply of resources is greater than the needs and living standards of its people. After that it is not self sustaining. It should be a basic concept in social studies of the grades, high school and college that no nation can permanently endure as a world power which consumes its renewable resources faster than nature, with the help of enlightened scientific aid, can replace them (Darling, 1940). We must teach our youth that national security, progress and world leadership are impossible without an abundance of basic resources and that our democratic ideals with their high moral and spiritual benefits will be dangerously weakened if our resources are squandered.

It seems to me there is no clearer lesson for them in history than that men and nations are laying the foundations of their own destruction when they violate nature's inexorable laws and unwisely use and waste basic resources. There is much evidence that ruinous land and water practices sounded the death knell of the great kingdoms of Babylon (Lowdermilk, 1950) and other ancient civilizations in the Mesopotamian valley, in Phoenicia, Carthage and the Land of Canaan. Later it appears that the destruction of natural resources was a major factor in the decline and fall of Greece and Rome. China's unwise and over use of land and its mantle of protective cover, along with her overpopulation, undoubtedly are the primary causes of her present economic plight and her defection to Communism.

America's large number of ghost towns that were once thriving communities are nothing more than tombstones to dead resources. They are monuments to short-sighted exploitive policies in such businesses as lumbering, grazing, mining, fishing and farming with accompanying land booms and unwise drainage. They leave us little room to point the finger of scorn at others. If we are wise we will learn a lesson from these before it is too late—and we will try to establish right attitudes of conservation ethics from the grades on up.

Every school child has been taught that America is blessed with a greater abundance and perhaps with a greater variety of essential resources than any other land on earth. These include our precious and productive soil with its agriculture and livestock, a well distributed supply of clean usable water for home, agriculture and industry, our forests, grass, fish and wildlife and our minerals and fuels and the matter and energy they produce. At the same time our youth needs to know that it is partly through the unwise exploitation of these resources that we have become temporarily, at least, the richest nation under heaven. Further they need to realize that in the relatively short period of our national existence we have made more prodigal use of these resources than has any other people of history in a comparable period of time.

WHAT IS CONSERVATION?

In the educational process it cannot be over emphasized that the term conservation as applied today does not mean to lock up or merely protect these resources. It means the wise use of resources for all our people—the greatest good for the largest number not only for the present but for the future as well. It means wise use without abuse.

EARLY CONSERVATION STANDARDS

A few patriots even as early as revolutionary days, such as Jefferson, Washington, Thomas Paine and Patrick Henry, stressed the need of wise use of resources, but no concerted effort was made at that time to accomplish this.

While the importance of conservation has been at least partially understood and appreciated by some of the wiser leaders of organized society since the earliest dawn of recorded history, the term as now applied came into use only a little more than a half century ago through the wise and dynamic leadership of President Theodore Roosevelt and his able friend and forestry chief, Gifford Pinchot (Coyle, 1957).

Had American leadership since 1908 heeded the warning of President Teddy Roosevelt we would be much more secure today than we now are. Before the historic Governors' Conference which he called he said: "Facts which I cannot gainsay force me to believe that the conservation of our natural resources is the most weighty question now before the people of the United States. If this is so, the proposed [this] conference which is the first of its kind will be among the most important gatherings in our history in its effect upon the welfare of our people."

That ancient Persia recognized the social immorality of destructive land practices is shown from one of its old proverbs which reads: "God will not seek thy race nor will he ask thy birth. Alone he will demand of thee 'What hast thou done with the land that I gave thee?' " The people of ancient Israel were enjoined similarly. The unwise stewardship of resources caused the Lord to remind his people (Leviticus 25:23) that ". . . the land is mine, for ye are strangers and sojourners with me." This philosophy is as fundamental to the preservation of our own society as it was in ancient times. It implies, and history confirms, the social wickedness of passing on to unborn generations a land and its resources impaired or wasted by selfish and thoughtless exploitation. America will be more secure when its people realize that upon individuals and peoples of each generation is imposed stewardship of land, while enduring ownership must be held in perpetuity by society of this and every succeeding generation (Cottam, 1947).

American Resources

Instead of picturing America as a land of inexhaustible resources, our schools need to paint the true picture. With the rapid rise of population and over exploitive use of our national wealth, the resource picture in America is rapidly becoming more unfavorable. In 1880 our population was 50,156,000; by 1900 it had reached 75,995,000; in 1920 it was 105,711,000 and now it exceeds 173 million. By 1975 we may be nearing the 230 million mark (Cook, 1957; Spengler, 1956). Some prognostications indicate that we may have as many as 300 million people in the United States by the end of the century! (Osborn, 1957). Our population growth since World War II has been increasing at an average rate of nearly 1.75 per cent, which is above the world average. This is the highest per cent of natural increase of any of the great industrial nations and it is higher even than the rate of increase for India, Japan or Italy where overpopulation is serious. Without considering immigration, it results in more than 2½ million additional people each year.

While this population curve is rising, our per capita income is slowing down and threatens prosperity because our resource consumption cannot keep pace with population increase. In 1950, the United States comprised about 9.5 per cent of the Free World's population. At that time our consumption of petroleum, rubber, manganese and iron was 24 per cent to 85 per cent higher than elsewhere outside the Iron Curtain. We also consumed nearly as much zinc, copper, and lead as did all the rest of the non-communist world. Generally our per capita consumption of raw materials, other than food, is slightly more than ten times as high in the United States as in the rest of the Free World (Spengler, 1956). Our consumption of water is 22 times as high as that of European cities. With perhaps 6 to 7 per cent of the world's population and land area the United States is absorbing half of the world's raw materials (Cook, 1957). And the rest of the world is trying desperately to raise its standard of living, which, even without population increase, means greater drain on raw materials and natural resources. The world population is growing at the rate of about 30,000,000 per year!

In 1900 America produced some 15 per cent more raw materials than she consumed, exclusive of food. In 1950 we consumed 10 per cent more raw materials than we produced. In many cases our exports have turned to imports and our consumption of raw materials is growing at a compounded rate. If we continue to expand our consumption at the same pace for the next 25 years, our needs would amount to 80 per cent of present world production. To illustrate this point further: Since 1914 the United States alone has consumed as much irreplaceable mineral and fuel resources as had been used by the entire world from the time of the first cave man to 1914 (Rickover, 1957). It seems painfully clear that the world is not keeping pace with the growing requirements of rapidly increasing populations, and in many countries, even in the primary category of food supply (Osborn, 1957).

It is dangerous and it puts us in a fool's paradise for "TV," our press and our schools to picture ours as the richest land on earth, with an unlimited supply of materials always forthcoming. While America is still rich by comparison with most other great world powers, we cannot escape the distressing fact that in less than 182 years, since the signing of the Declaration of Independence, we have changed from a sparsely populated, fabulously resource-rich country to a rather densely populated and relatively resource-poor country today. Like the prodigal youth we have riotously consumed or destroyed much of our capital stock when we could comfortably have lived on its interest.

We have cut four-fifths of our original timber stands and we have so overgrazed our western ranges that their carrying capacity is probably not over one-third of what it was a century ago. More seriously still, we have so abused our agricultural land that about one-fifth of the original lands are no longer able to support profitable farming and one-third of the remainder is impaired (Bennett, 1947). Despite the great work of Dr. H. H. Bennett and his Soil Conservation Service, we are still pouring nearly ½ million acres of farm land annually into the Gulf of Mexico, our oceans or into our lakes. Yes, America is still rich, but when compared with our resources of even a few years back we are poor; and when we measure our present resources and assets against future needs we are poor indeed.

Can there be any question that pressures will develop by peoples within countries and between countries in their efforts to secure needed resources and to maintain and improve their standards of living? It seems clear that population increase, resources and markets on one side of the balance are not unrelated to economic crises and a possible welfare state on the other. Personal liberty and respect for the individual generally decline where resources are inadequate to meet the needs of the people. People are not likely to fight for water or bread except when and where these are in short supply. Peace, progress, security, personal liberty and happiness of individuals and nations are possible only when natural resources are sufficient to supply basic needs and to enable people to enjoy a reasonable standard of living.

How Can We Develop and Retain a Satisfactory Resource Base?

To secure a satisfactory resource base two major steps lie before us and we must take both of these immediately:

1. We must cease and desist from our past wasteful extravagances and live within our resource income.
2. We must give effective support to both basic and applied scientific research as it relates to our natural resources and particularly to our renewable resources.

Brief discussions of each of these follow:

(1) Conservation must be made a part of the consciousness of all our people. We must more effectively "sell" the story and its importance to our people beginning with our youngsters in school, Boy and Girl Scout groups, religious youth groups, 4-H Clubs, Camp Fire Girls and others. In some way we need to reach the key men in educational administration—the ones who determine policies, choose courses of study and initiate the writing of textbooks. New attitudes toward

conservation can thus be gradually inculcated. Another point of great influence is in the educational training schools of our colleges and universities. Attitudes and points of view are often determined on this level. Teachers themselves need to be taught the need of wise use of resources or they cannot teach our youth. They need to be given the facts and shown how to teach conservation and how it can be applied.

Our people have grown up under the delusion that our natural resources are practically inexhaustible and that America could feed the world. Consequently, our educational system has been painfully deficient. Until the basic facts and the philosophy of conservation become a part of the consciousness of national and state legislators, governors, presidents and cabinet members and other chief administrators we shall continue to be in trouble and our natural resources will continue to receive more lip service than bona fide support. Until then it will continue to be bartered by politicians for political or personal advantage rather than to be wisely regulated by statesmen. America has had great statesmen but unfortuantely it also has had too many faithless servants in high positions who stupidly, maliciously or inadvertently caused or permitted great destruction to our God-given resources. I believe a better day may be dawning.

(2) Basic and applied research in scientific fields pertaining to our natural resources—agriculture, soils, water, wildlife, fisheries, forestry, range management, wood technology, plastics, health, education and others—are probably of greater significance to our national and individual survival and well being than is the necessary, but at times quite unlimited support, given to the production of satellites and missiles or to the military or foreign aid or some other emergency that has caught us unprepared. Each of these major sources of administrative support is important and must be properly directed and financed. Still, would there be more national suffering or a greater injustice done to our beloved America if we were quickly obliterated with enemy missiles than if we should have our economic resource foundations drained out from under us? The latter already is occurring and I believe there is much too little recognition of this fact among most policy-making leadership both nationally and on the state level.

Perhaps we aren't reaching the right people. Government, too frequently, is little more than rule by emergency. Perhaps our security would be greater and we would have fewer emergencies if we had more advanced and objective planning (with pork barrels and log rolling removed) and if more adequate support were given sound research followed by development and management. To my mind this research is no less an emergency than is the preparation to meet a foreign foe. I believe we can best contribute to peace by building up our own resource security.

It is well to emphasize the fact that the shrinking of the once broad materials base of our industrial civilization makes us for the first time in our history dependent upon imports from foreign lands for materials essential for our technical organization. Thus far we have encountered no serious difficulty in buying materials needed. It would be unwise to expect that either a shooting war or a shift in a cold war would not change this. "We shall not remain truly free and powerful unless we compensate to the fullest possible extent for lack of materials resources within our own borders" (Rickover, 1957).

It has been said that the most valuable undeveloped resource in the world is brain power. We must substitute intellectual resources for diminished materials resources. We must encourage a larger number of superior young scientists to tackle these natural resource deficiency problems. New and better methods of approach must be developed and we must find ways and means of substituting plentiful and cheap materials for scarce and expensive materials. We must find more efficient and less expensive ways of extracting necessary minerals, oils and other products from areas that are now not economical. The approach used so successfully in developing plastics and synthetic rubber must be expanded so that other items in short supply can be replaced by something else that is cheaper but equally as good or better.

We must remember that as population increases and society becomes more complex technologically it needs proportionately more and better trained professionals. This is as true in biology and resource management as it is in physics, engineering, mathematics or chemistry. While the population of the United States has doubled in the last 50 years, the number of its professionals has quadrupled. We now have five times more engineers and ten times more scientists than we had a half century ago, and yet these specialists are in short supply. With every forward step technologically a nation becomes more dependent upon research and brain power. And the more scarce a given resource becomes the greater the need for trained research and management.

Research must stress the basic or fundamental phases as well as the applied. Experience shows that advances in technology have almost invariably been slower when theoretical knowledge failed to move forward. Empirical methods cannot be used indefinitely in this scientific age.

SOME BASIC RESOURCE PROBLEMS NEEDING SOLUTIONS

Perhaps, as a means of solving our dimnishing resource problems this superior brain power needs to be used to awaken America from its slumbering lethargy and give its people a greater sense of relative values. We must devise more effective methods of "selling" conservation to the public and particularly to our educators and to our elected officials. When this is a reality we shall have fewer worries about our security, our freedoms and our future.

A major need in the conservation and management of natural resources is effective coordination in their administration and research. More team approach type of basic research is needed. Conflicting demands for land are most easily and equitably resolved when administration, management and research personnel have an understanding and an appreciation of the whole problem involved (Graham, 1956).

We need to know much more about the causes and relationship of different land practices to our constantly falling water tables and the relationships of these practices to soil moisture, temperature and soil chemistry and the effects on crops and on the vegetative covering of the soil.

More basic data are sorely needed on the processes, causes, prevention and cure of erosion. We need to know far more about man-made causes as well as natural causes of erosion. The process and causes of sediment movement are not well understood. It is difficult to assess accurately and quantitatively the effect of a particular change in land use upon water and sediment in any given area of drainage. We still know far too little about the movement of sediment or the movement of water in nature. The processes of sheet erosion under a forest cover are poorly known (Special Committee, 1957).

The basic field of soil-plant relationships needs much more scientific study and evaluation despite the fact that some $1,840,000,000 are spent annually on commercial fertilizers. We need to know much more precisely what elements are essential plant nutrients and what other elements are used and why. We also need much more precise information about the physiochemical processes by which growing plants assimilate nutrients (Special Committee, 1957).

Climate, although long recognized as a major factor in plant growth, has received little integrated attention from research workers. Relatively little is known about the interrelationships between water supply and plant growth. Much more precise data are needed on the relationship of temperatures and plant growth. A clearer understanding of plant processes may greatly expand the horizon of man's use of plants and enable him to make much greater use of abundant species presently of low economic value, particularly of most shrubs and trees (Special Committee, 1957).

Basic research on population dynamics is urgently needed as a base for sound management of both wild and domestic animals. Biological studies on density phenomena, community interactions and stress factors are sorely needed (Special Committee, 1957).

Research to determine the mechanisms resulting in the formation of rain would enable a sound approach to be made to the problem of weather modification. Under present conditions only empirical and unscientific approaches can be made (Special Committee, 1957). Likewise we need a cheap process of converting sea water into fresh water for communities, agriculture and industry.

Forest genetics research like many other lines of plant and animal breeding should certainly be stressed as it seems almost certain this would greatly enlarge our resource base.

As our population expands and our resources further decline we shall surely have to rely much more heavily on the sea for food and for many other resources. We need to know much more about how specific chemical characteristics of sea water affect its fertility. We must know much more about what substances and other conditions inhibit or produce growth of marine organisms (Special Committee, 1957).

Science needs to give us an effective blueprint of procedures for deriving better multiple purpose benefits from more of America's public and private lands. For example, we need far better procedures of how to best integrate sound wildlife management into profitable agriculture, forestry and grazing programs. We also need more knowledge of how different land practices affect different wildlife populations. Specifically, we need to know much more precisely the effect different soil conservation practices have on different species (Cottam, 1957).

Basic research on environmental relationships of the entire biological community is greatly needed. We must know very much more of the inter- and intra-species relationships under differing conditions such as population densities, various land use practices and climatic or weather conditions (Cottam, 1957).

The broad subject of plant and animal control and the effect control agents have upon man, the soil and its organisms and on all domestic and wild animals that live on the land is in sore need of careful scientific evaluation. Likewise intensive studies of disease, nutrition and pathology are urgently needed on our native and introduced flora and fauna (Cottam, 1957).

We need basic studies of the value and limitations of our wetland resources and of how they can best be managed in the public interest.

In the field of recreation we must devise better means of getting more enjoyment and relaxation out of smaller and smaller per capita space for tourists and sightseers and smaller home-take for more fishermen and sportsmen. Last year some 59 million people visited our national parks, 52½ million visited national forests and 7½ million visited national wildlife refuges. Of 12 year olds or older nearly 21 million went sport fishing and nearly 12 million went hunting last year.

A CURRENT SCIENCE PERIL

The above are but a few illustrations of a great many fields of research into our diminishing resource base that are calling loudly for scientific answers. In the main these studies are largely biological. It is almost frightening to realize that government on the federal level devalues or at least apparently does not realize the need of giving support and encouragement to scientists and other workers in these biological professions. Such action seems to indicate that Government currently regards biologists as second-class citizens! In 1954 a federal law was passed which permits the Civil Service Commission to adjust rates of pay in those fields where the supply of professional personnel is not adequate for the demand, where sufficient eligibles therefore cannot be secured for what are considered as essential jobs in government. Recently the Civil Service Commission ruled that personnel in specified categories would be moved to the top of their respective grade. These included professional engineering, architecture, physical administration, physics, electronic research and development, chemistry, metallurgy, geophysical exploration and development, mathematics, and certain technological specialties such as rubber and plastics, food processing and packaging. Only those biologists and basic resource specialists are included whose specialties place them in the chemical areas.[1] Liberalization in reallocations for higher positions and pay has also at times, I believe, been given workers in these favored fields as a further means of competing more favorably with private industry.

It seems to me such policies encourage the most outstanding resource scientists to leave government and their work on renewable resources regardless of how essential such personnel are in their specialties. Such discriminatory favoritism implies low value on professions outside the favored categories and it surely will discourage superior students from entering those fields. Discriminatory rulings and preferential pay for comparable service are bound to create unfavorable employee relations in government and particularly where technicians and sci-

[1]Letter Dr. T. D. Fontaine, Nat. Sci. Foundation, 2/13/58.

entists are working as a team on resource research and management. This preferential treatment has a tendency to assign more and more of the responsibilities of the scientists in the non-favored fields to specialists in the favored categories, thus diminishing the quality of team research that should be performed. More importantly the present trend seems to me to indicate a profound lack of understanding and appreciation of the importance of basic resources in America.

In conclusion I cannot too strongly emphasize the profound importance of a scientific approach to the management of America's resource base. Constantly changing conditions always will require new information and new techniques to meet new problems. While there is an urgent need for more effective coordination among federal and state agencies administering our basic resources there is perhaps still greater need for more effective research and deeper digging. Unless our resources are managed more scientifically and more fresh brain power is applied to our resource problems, America most assuredly is headed toward being a have-not nation. Our security, our progress and our freedoms are clearly at stake. "Without vision the people perish"! Are we equal to the challenge already upon us?

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DISCUSSION

DR. STEBLER [Oklahoma Cooperative Wildlife Research Unit—Stillwater]: I would like to say that I endorse Dr. Cottam's remarks heartily and would like to add, by way of comment, that we here certainly all recognize the importance of wildlife conservation. However, I don't think that we have gotten far enough in our recognition of the over-all worth and appreciation of wildlife conservation. The matter of education certainly is an important consideration here and it seems to me that we are faced with the problem of raising or cultivating some generations of people to take over in our places so that we will have a much broader appreciation of wildlife values than we generally recognize today.

We are faced and concerned with very many problems in our human world. Most of the problems that we face are a result of our own conditioning. They are a part of our cultural heritage and by way of research in wildlife I think it is possible to learn that we had the perception to see the full extent of our learning.

I think that in any curriculum that we are concerned with that we should have something of the study of life and that it should be broad enough to embrace all life—that it should be broad enough to embrace not only our own welfare but the welfare of all other living creatures.

MR. BROWN [Idaho]: I think that I will join with all of the others in the room in saying that those remarks were very wonderful. However, I would like to ask, what are your thoughts on the place of conservation education in the curriculum of our public school systems?

DR. COTTAM: My own feeling is that anything that deals with something so basic as our very existence, our future, our progress, and our security, cannot be left out of our schools. There may be vast differences among us as to how it should be applied in the schools—maybe not as specific courses in the lower grades but as part of the sociology or citizenship training so that we will be better Americans and take a greater interest in this great country in which we are privileged to live. It ought to be taught either indirectly or directly in the grades, even in the high schools and colleges, because it is fundamental to our existence.

BOY SCOUTS AS CONSERVATIONISTS

CHARLES M. HEISTAND

Assistant Chief Scout Executive, Boy Scouts of America, New Brunswick, New Jersey

I am sincerely grateful to the Program Committee of this conference for the opportunity to represent the B.S.A. on the program. We appreciate very much the fact that we are on the program for the recognition provided of our conservation program. We deem it our honor to be asked to talk about our activities in a general session of the most important conservation conference in this country, if not the world. But most of all, we are happy indeed to be able to do something that has needed doing for many years.

That is to express formally and publicly our thanks and deepest gratitude to the professional conservationists of America for their help to Scouting at all levels of conservation administration. I hesitate to think where our program would be without the close cooperation and assistance that we enjoy from you folks who dedicate your lives to conservation. To be most candid with you, in all probability we would have no national conservation program were it not for your help.

Basically, as you know, the Boy Scouts of America is not a conservation organization. We are chartered by Congress to develop and operate a program for boys that, among other things, trains them in good citizenship. There are few other activities that contribute to this objective better than an active, meaningful program of conservation. We just do not see how any boy can be trained in citizenship without being aware of the increasing importance of our natural resources, our obligation as individuals to work toward wise use for the good of all Americans, and an understanding of some of the fundamentals of ecology and resource management.

Consequently, elements of conservation are woven into our program for all boys—over 3½ million of them—from Cub Scouts (aged eight) to Explorers (aged fifteen and up). Since our program locally is administered by some million and three-quarter adults, it stands to reason that we are doing some adult education in conservation at the same time.

So while we are not fundamentally a conservation organization in the sense that all of our efforts are directed toward conservation activities, conservation is so firmly established and so intricately woven throughout the program that no boy can be a Scout for very long without at least becoming acquainted with the word and knowing what it means.

Boys of today will be the voters of tomorrow. More than that, they will be the farmers, the bankers, the industrialists, the businessmen, the men in the government—yes, the politicians. They will be the sportsmen, too, and a reasonable number will join your ranks as professionals in conservation.

For many of them, all the experience they will ever get in practical conservation, they will get in Scouting. So by working with Scouting now and helping us put across our program (which you fellows developed), you may well be making your own future easier. If our program is a success when today's boys become adults, whatever their career or place in society, they should be able to help you. We like to think so anyway.

There is another aspect of our conservation program, too, that we regard as tremendously important. Through the merit badge program and such special features as conservation camps, we are making a sincere effort to educate boys in the importance of the biological sciences—and to attract top-notch young men to careers in conservation and the biological sciences. We recognize full well the importance of the physical sciences to the future welfare of our country. But we recognize, too, the necessity of seeing to it that the biological sciences are not slighted, if we are to be able to meet the needs of our growing population. We think that our soil and water, fish and game, grass and forest resources are rather important to the future of the country and cannot be disregarded in this day of atomic energy. In our conservation program, we have the means of attracting boys to the field of biology. We will continue to use it to that end.

But the title of this paper is "Boy Scouts as Conservationists," and I assume that what is wanted is a rundown on what boys are doing nationwide. First, though, I wanted to thank all of you for your help, so in this section if I overlook one state or one pet project, you will forgive me.

In describing what boys are doing specifically, let's start with those that earned the three conservation merit badges. We have statistics in this case, which are reasonably accurate. Then, too, these badges represent probably the highest degree of knowledge and skill in the conservation phase of our program. When a boy earns one or more of these badges under a sincere, conscientious counselor, we believe that he has a fair grasp of a few important fundamentals. Let me illustrate from some of the requirements for the Soil and Water badge:

1. Determine the depth of topsoil in at least two contrasting areas, such as grazed and ungrazed woods; cultivated fields and fields left in grass; grazed pastures and ungrazed haylots; well-kept lawn and heavly cropped garden, etc.
2. (a) Describe the different types, causes, and results of soil erosion.
   (b) Show snapshots or rough sketches of two examples of erosion in your community.
   (c) Explain what is meant by soil depletion.
3. Explain the meaning of the following terms:
   (a) contour farming
   (b) strip cropping
   (c) rotation of crops
   (d) terracing
   (e) cover crops.
4. On a road map or similar map, point out the watershed area for your community.
5. Make a diagram-sketch, showing how rain water falling to the ground eventually gets to your kitchen faucet.

6. Explain how man's use of land in the watershed affects your community's water supply.
7. (b) Make a study of plant, animal, and fish species in a pond and, if necessary, carry out such practices as will increase the fish population.
   (e) Take an active part in removing the cause of pollution of a stream, pond or lake.
   (h) Find out what is done with domestic and industrial waste in your community and write at least 500 words on the methods used to prevent pollution and to purify your water supply.
8. Help carry out a soil conservation project on a farm or Scout camp, cooperating with the local soil conservation district.

Some 17,000 boys earned that badge last year and more than 70,000 have earned it since 1952.

Now let's look at some of the key requirements in forestry:

2. (a) Describe the value of forests in protecting soil and building fertility, regulating the flow of water, wildlife management, and as recreational areas. Tell from what watershed or other source your community obtains its water.
   (b) Describe briefly the part that forest products play in our everyday life.
3. (a) Make a diameter tape or Biltmore stick. Show how to determine the height and diameter of trees. Estimate the board foot volume of three trees selected by the counselor. or
   (b) Examine ten stumps or logs and discuss the reasons for variations in the rate of growth from the rings.
4. Describe what is meant by sustained yield forestry.
6. (a) Describe the damage to forests and watersheds resulting from fire, insects, tree diseases, overgrazing, unwise cutting practices. Tell what is being done to reduce this damage.
   (b) Tell what to do if a fire is discovered in woodlands.
   (c) Take part in a forest fire prevention campaign or build a fire lane of at least 100 yards at a location designated by a local fire warden or forester or counselor.
7. (b) Visit a managed public or private forest area or watershed area with its manager or supervisor. Write a story of about 500 words on how they manage the forest to grow repeated crops of timber, to protect the watershed, or to provide other services and benefits.
   (c) Help a forester, wildlife expert, or your counselor in some forest project that will benefit wild animals.

More than 24,000 boys earned that badge last year and some 121,000 badges have been awarded since 1952.

Wildlife Management is the newest of the three merit badges. It was instituted in 1952, when 2,311 badges were awarded. But in 1957 more than 14,000 boys earned the badge and some 62,000 have been awarded since 1952. Listen to these requirements:

1. Do one:
   - (a) On a rough sketch of a five-acre area—
     - (1) Show and identify the chief types of plant cover
     - (2) Show the location (and identify) nests, dens, runways, droppings, feedings, and other animal signs.
   - (b) On a five-acre area—
     - (1) Identify three of the chief tree, three of shrub, or three ground cover species used by animals for food, shelter, or cover.
     - (2) Identify by signs or sight, ten of the animal species found in the area.
2. Describe the value of three wild animals, each as sources of food, clothing, and recreation; and the role of three animals each in insect, weed, and rodent control.
3. (a) Describe the damage to wildlife resulting from wildfire, overgrazing, unwise forest practices, soil erosion, unwise drainage, "slick and clean" farming, and water pollution.
   - (b) Explain the relationship between wildlife and the natural habitat and how man controls the natural environment.
4. Explain who makes laws setting definite seasons and bag limits on hunting, fishing, and trapping in your state and the reasons for the laws.
5. (a) Make a wildlife count on each of two contrasting approximate five-acre plots. Grazed versus ungrazed wood lots; or strip cropped versus solid planting; or burned-over versus not burned-over area; or other contrasting areas.
   - (b) Visit a state or federal or private game refuge or game management area with a wildlife technician and write at least 500 words on what is being done to make the area better for wildlife.
   - (c) Visit a game farm or fish hatchery with a wildlife technician and write a report of at least 500 words on the pros and cons of game stocking against habitat improvements as means of increasing wildlife populations.
6. (d) Set out 200 food plants for birds and mammals.
   - (e) Build three check dams, deflectors, or cover devices in a

stream or lake, to provide shelter for fish and to help reduce erosion.

(f) Study the fish species in a pond or lake and, if necessary, carry out such practices as may be necessary to benefit the fish.

(i) Help plant a gully, road cut, fill an eroding area, to reduce erosion, building up soil fertility, and at the same time provide shelter for wildlife.

You will note something else in these badges. While they seem to specialize in one of three major fields of interest, they all stress the interrelationship of all our renewable resources. A boy selects forestry because of a natural interest in the subject—but he cannot earn the badge without knowing something about the relation of forests to wildlife, water levels—yes, watershed management, and recreation, as well as wood products.

Scouts going through our advancement program to Eagle must earn *one* of those three badges, but all Eagle Scouts must earn the Nature Badge.

Here are some of the requirements:

1. After personal investigation, select for study one typical wildlife community approved by your counselor (forest, field, marsh, pond, desert, mountain top, ocean shore, etc.) near your home, or your favorite camp site. Take at least two hikes within that area and do the following:
   (a) Submit a list of the most commonly found plants (trees, shrubs, flowers, grasses, etc.) and animals (mammals, birds, reptiles, amphibians, fish, insects, mollusks).
   (b) Report on kinds of soils and most commonly found rocks.
   (c) Describe springs, streams, lakes, and other waters found.
2. From reading or talks with your counselor, tell how temperature, wind, rainfall, altitude, geology, tide, wild or domestic animals, or man help make the selected area what it is. Tell what is meant by the term "plant succession." From reading or talks with your counselor, tell briefly what successions have occurred in the selected area in the last hundred years and what would probably happen in the next hundred years, if the area is undisturbed by man.
4. Select one species of plant, mammal, bird, fish, reptile, or amphibian and, for personal observation and reading, write a simple life history (how and where and when it originated; how it grows; what it eats, what eats it; migratory habits, if any; how and where it spends the winter; its natural home, etc.).

This, too, is a new badge, set up in 1951. In 1957, more than 35,000 boys earned it, with a total of nearly 150,000 since 1952.

In those merit badge requirements, we think that we have a sound program. But it should be. You folks helped write them. However, we will not become complacent. Our work schedule for the next three years calls for a restudy of those requirements at grass-roots level. Do they really get across the important concepts of conservation? How can we improve them so that counselors and boys have fewer problems? Are we kidding ourselves when we think that they are an effective means of teaching fundamentals that boys will remember as they grow into manhood?

All boys do not work on merit badges. To be sure that those who don't are still exposed to training in conservation, we suggest that one month each year be devoted to a conservation theme in all troops across America. Whether that theme is carried out depends upon a number of things— the personal interest of the leader and the availability of technical help being the key reasons.

In April of last year, the theme was in the field of fish and game conservation.

In an effort to stimulate more activity at troop and boy level, activities that make for the kind of attitudes that we need across the country, three conservation organizations made available a special program kit to each Scout troop and Explorer post in the country—70,000 altogether. These organizations (the Sport Fishing Institute, the North American Wildlife Federation, and Wildlife Management Institute) contributed a total of $12,000 toward the publication of the kit and the text was prepared with the help of the Fish and Wildlife Service, the Forest Service, and the Soil Conservation Service.

While it is not practical to try to evaluate all that happened as a result of this project, we do have a good indication that it was successful and did fulfill its function.

From Michigan came reports of hundreds of woodduck boxes being made from salvaged five-gallon oil cans and set out on state public hunting and fishing grounds; from Michigan also came reports of bass spawning boxes set out in silted lakes. Both of these activities were followed by success stories—woodducks and smallmouth both used the facilities provided for them.

From Arizona came reports of one council building thirty check dams on part of one national forest to control erosion and keep silt out of a river. From upstate New York came reports of several thousand feet of hedgerow being planted for food and cover. From New

Jersey we heard of nearly a hundred tenth-acre food plots being planted on Scout camp properties and public lands—planted by boys as part of their conservation program.

From the Northwest came reports of Scouts collecting tree seeds in cooperation with the Forest Service.

Scouts from Buffalo, New York, area reported many interesting projects. Fish kills have become numerous in the rivers there, so the Scouts have been tracking down the source of these kills. They have found that leaks in oil barges and waste from the manufacturing plants have been mainly responsible.

In the strip-mining sections of Kansas, Ohio, and West Virginia, Scouts reported that they have been doing something about those ugly scars left on the land. They have stopped erosion with brush on the strips. Christmas trees are piled on some strips and some of these are used for bird shelters. Black walnut seedlings are planted on some of the strips. In other places the Scouts have even made fishing holes out of the pits and landscaped the areas.

Oakland, California, Scouts told us of their extensive terracing and tree-planting projects to prevent erosion. They also planted ground cover and fruit-bearing shrubs for birds. Shoreline cleaning and control is part of their program.

A Paul Bunyan program has been in full swing for two years in the Northwest. At Camp Cowles on Diamond Lake, Washington U. S. Forest Service men mark trees for cutting, then Explorer Scouts fell, trim, and saw them into logs. These Scouts even brought some horses to snake the logs out of the forest en route to the saw mill. Afterwards they stack and burn the brush.

Converting a farmland into a natural wooded area is a project of Fond du Lac, Wisconsin Scouts. With the enthusiastic assistance of local county agents, these Scouts are planting 3,000 trees a year to reach a goal of 15,000. They are using transplants rather than seedlings to reduce the mortality rate.

These are only a few of the things that happened at boy level as a result of this program kit. Naturally we are happy to have had a hand in it and for the chance to help stimulate such activities that are important now, but which will be much more important in the future as these boys grow up and start to apply some of the concepts they are learning now.

Next month, the theme will be in the area of soil and water conservation. Thanks to the National Association of Soil Conservation Districts and the Soil Conservation Service, another excellent program kit is now in the hands of some 70,000 leaders across the country, as they plan for next month's program. In 1959, the theme will be forestry, as it was in 1956.

Again I want to emphasize that these themes are merely hooks on which a leader may hang a troop program for a month or more. Each one stresses all renewable resources and their inter-relationship.

I cannot close this paper without bragging a little, and in so doing I am again paying tribute to you professionals in conservation and especially those of your number from the Federal agencies and the States of New York, New Jersey, and Pennsylvania, who helped make history at Valley Forge last summer.

Last summer we held our Fourth National Jamboree at Valley Forge, attended by some 53,000 boys and leaders. One of the highlights of the jamboree—certainly the most popular and best attended of all voluntary jamboree program features—was our conservation program. That program was two years in the planning, eight months in the construction of the physical layout, and one week in actual operation.

About 200 men were involved in all phases and 22 federal, state, and independent agencies cooperated, including the Wildlife Management Institute. In addition, three national industries made valuable contributions in materials needed for construction.

In that one week, 38,000 boys and leaders were exposed to at least two hours each of instruction—instruction in fundamentals of soil and water, forestry, fish and game management. The instructors were 120 professionals in conservation, men like yourselves who lived on the grounds, teaching during the day and spending their evenings getting ready for the next day's horde of ten to twelve thousand boys. I wish time permitted paying tribute to each of the organizations and the individuals responsible for this tremendously important stimulus to our conservation program.

As I close now, I want to say thanks again in behalf of Dr. Arthur A. Schuck, Chief Scout Executive; Irving Feist, chairman of the National Conservation Committee; and members of the committee; in behalf of Ted Pettit, our director of Conservation; and personally, thanks to all of you for making our program what it is. I feel confident that your efforts in cooperating with the Scouts will pay off for both of us and will go a very long way toward creating a better climate across America for conservation as a whole, and your special phase of it in particular. Together we can help guarantee that our renewable resources will be well managed for the good of *all* the people, for *all* the time.

DISCUSSION

MR. BROHN [Missouri Conservation Commission]: I would like to ask in which direction you think we ought to place our emphasis in our cooperative work with the Boy Scouts. In the metropolitan area we have frequent requests for scout leaders to help the boys with conservation projects and merit badges, and we are somewhat at a loss as to how to put these boys out on the ground where we can see them do the things they ought to do—or should we devote our time to teaching these boys to become familiar with what conservation means?

MR. HEISTAND: I would think that first you should discuss with the local scout officials what you as a conservationist might develop. There are two things that must happen. The first is that the boys want to do things. If you just tell them or show them, that isn't enough—they have got to do something. Therefore, I think that it is important with the city boy that we show them. Then have them do some things in cooperation with the City Park Department or with the City Water Department. Maybe they can go out of the city to the watershed areas, and do some work there.

The other important thing is that most of our councils own large summer camps. You will be interested to know that the people of America (not the Boy Scouts) have invested over $50 million in Scout camps. It would appear to me that you could then work out a program to utilize that camp and use it as a conservation area and have them do their work there.

MR. KLEWER [Outdoor Editor, Toledo Blade]: I would like to say a brief word to those who may not know the practical application of scouting. I speak mainly of my own experience in the City of Toledo and give you a practical exchange of what Boy Scouts can do. At the National Wildlife Federation meeting the other day I was listening to various state reports, and I turned to the fellow next to me, also from my town and said, "I should tell them about Troop 28 and make them all ashamed." I would like to tell you just what one troop has done.

That troop, during the past seven years, has had 274 consecutive weeks during which, each week, they completed some practical conservation program. That troop had more than 300 consecutive days of conservation work; in its seven years, has planted more than a half million trees; has made and distributed several hundred duck boxes. They have also distributed thousands of bird boxes—everything from little wren boxes up to martin houses; they have riprapped several miles of trout streams; conducted bird and game counts; and built smallmouth bass feeding areas in various lakes. This gives you an idea of the practical things that some of these kids can do.

MR. WAEHNER [Colorado]: I would like to ask two challenging questions which are asked of me and which I could not answer.

First, what percentage of our population, say those between 21 and 65 were Boy Scouts? Secondly, if it is a very large percentage, then why do we have so much vandalism today in our outdoor recreational areas?

MR. HEISTAND: Well, in 1960 we will celebrate our 50th Anniversary and we have about 27 million of our population who have been Boy Scouts.

As to your second question, I don't think that I can give you an answer. I know it happens but then I would not attribute all of it to the Boy Scouts currently or in the past. Of course, I would attribute some of it to them because I know we don't make angels. I think that we must always take it for granted that some of our seed will fall in rocky ground and that some will bear fruit. That is the only answer that I can give.

MR. ALDRICH [Florida]: We in Florida feel that the approach to this conservation program is to encourage scouts to go through the advancement in their merit badges in the scouting program. We feel that the requirements of certain merit badges have been designed by some of the best conservation minds in the country and that our job is to encourage them in their own program. The kids will find the place to carry out and do the practices that are required on those merit badges. We propose to encourage it through awards by the state, to support their own program that is so well established at the present time.

CHAIRMAN FEIST: I would like to say that the impact of the Boy Scout conservation program is really taking place now.

Secondly, I just have had the privilege of making an annual report to the Governor of the Virgin Islands and, while I was making the report, he told me that before he became the Governor he had been a parole officer in the State of California. He had heard over seven thousand cases and, of that number, only one had been a Boy Scout.

4-H CLUBS PRACTICE RESOURCE MANAGEMENT

GEORGE FOSTER

Chairman, 4-H Club Development Committee on Conservation of Natural Resources, Knoxville, Tennessee

More than 2 million 4-H Club members have dedicated themselves to wise use and conservation of natural resources. In 1956 alone (the latest year for which complete figures are available), 65,649 boys and girls were enrolled in forestry 4-H Club projects and 29,631 soil and water conservation projects. Another 34,000 4-H'ers took soil and water conservation as an activity. In wildlife and nature study, 82,502 boys and girls were enrolled. Also, 270,336 4-H Club members, including those in corresponding projects received definite training in soil and water conservation. Boys and girls attending a 4-H Club camp numbered 235,106; 1,271 medals were awarded county winners in 1,110 different counties in the National Forestry Awards Program and 2,354 in Soil and Water Conservation to members in 1,046 counties.

What do 4-H Club members do in resource management? A recent survey of the 48 states and 3 territories revealed the following information:

1. What are your present conservation projects?

   Forestry, maple production, outdoor life, soil conservation.
   Soil Building and land use.
   Soil Testing.
   Soil, water, sunshine.
   Pasture.
   Plan for 1958 (soil conservation by soil judging and conservation treatment).
   Timber stand improvement and low grade control projects.
   Plant identification project.
   Tree identification, tree planting, fire control projects.
   Wildlife food patch production projects.

Wildlife conservation.
Management of range and beef cattle.
Garden.
Entomology.
Let's explore the outdoors
Our birds
Saving soil and water.
Farm mapping & soil testing
Project titles
Land engineering

2. What are some of your use and conservation of natural resources activities?

State-wide conservation and forestry camp.
Forestry tour for 15 years and over club members.
County conservation camps, conservation days, forestry days, forestry tours.
State 4-H Club fish and wildlife conservation camp.
Timber estimating contests.
Forestry demonstrations.
Land judging contests.
Terracing and drainage contests.
Soil and water conservation contests.
State conservation schools.
Training school for leaders.
State fair exhibits.
Tours.
Special interest groups.
Nature hikes, bird hikes.
Tree identification.
Arbor programs.
Pine cone seed collection.
Tree planting demonstrations.
Cooperate with civic clubs in soil conservation.
Service in special conservation programs.
Water management: (a) cultivation, (b) terracing, (c) farm reservoir, (d) farm drainage.
Soils judging.

3. Which conservation projects and activities receive major emphasis in your present program?

Forestry project.
State conservation camp.
Fish and wildlife.
Soil testing.

Soil building and land use.
Soils and water.
Soil judging and water management.
Food and cover for upland game birds.
Individual conservation and forestry projects.
Land judging
Plant identification.

Let's be more specific and take one example of a 4-H Club activity in the area of resource management, state 4-H Club conservation camps. I recently asked Mr. George McCullough, Wildlife Technician, of the Federal Cartridge Corporation, to give me a brief run-down of the cooperation of his company with the Extension Service in promoting 4-H Club conservation camps. He reported:

"Twenty-four years ago, Mr. T. A. Erickson, then Minnesota 4-H Club Leader, called on Mr. Charles L. Horn, President of Federal Cartridge Corporation, to solicit his financial aid in promoting the conservation program with the 4-H Clubs in Minnesota. This resulted in establishing a conservation camp at the close of the first year's activities. Following that year's experience, Mr. Horn asked me to contact the leaders of 10 other north central states. This resulted in organizing a program and setting up camps in 10 additional states.

"We continued to expand the program and included all of the southern states, plus a few of the eastern states. As of this date, Mr. Horn supports conservation camps and programs in all of the 28 states, from Montana and as far east as Maryland, including all of the states north and south between these 2 states. As you know, 11 of the southern states have negro camps, in addition to their white camps.

"This past year, the attendance at the camps in the 28 states numbered 5,147 boys and girls, plus 1,127 adults . . . including leaders and those who serve as instructors."

Now for the look ahead. . . . What does the future hold for 4-H'ers in the Practice of Resource Management?

May I cite two examples of significant trends:

1. The establishment of a National 4-H Club Committee on Conservation of Natural Resources. Its broad purposes and abjectives are stated as follows:

   The purposes of this committee are to explore further and define the needs for conservation of natural resources by 4-H Club members and to develop a guide for programs and activities in this area.

   Such programs shall have as their major objectives the goal to develop on the part of young people:

a. Leadership talents and to work toward achieving the broad objectives of character and effective citizenship.
b. Desirable attitudes towards the need and importance of conserving of natural resources in relation to the welfare of individuals and the public.
c. A broad concept and understanding of the inter-relationships of the soil, water, mineral, air, trees and other plants and animal resources.
d. An appreciation of the economic and other benefits to be obtained from the conservation of natural resources.

Continuing to quote from the first report of this committee, they suggest:

"To illustrate typical projects and activities that could be conducted by 4-H Clubs or 4-H Club boys and girls in each of the six areas, we submit the following list. Some projects are quite specific while others are very broad and will require more specific treatment before formal publication.

Project Ideas Common To All Resource Areas

(1) Exhibits (for schools, fairs, etc.).
(2) Demonstrations (including applied projects on the land).
(3) Educational talks (for clubs, civic groups, radio, TV, etc.).
(4) Written articles (for newspapers, essay contests, etc.).
(5) Projection of visual aids materials about your conservation projects (slides, motion pictures, TV shorts, charts, graphs, etc.).
(6) Posters for public display.
(7) Organized tours to study conservation practices.
(8) Field days to demonstrate conservation practices.
(9) Plan special programs for schools (special speakers' films or organized campaigns).
(10) Develop conservation book shelves or libraries for schools, club rooms, and public libraries.
(11) Scrapbooks.
(12) Collections of natural history materials.
(13) Special programs for Conservation Achievement Day.
(14) Natural Resource survey on a specific area.
(15) Regional resources development conferences for senior 4-H Club members.
(16) Conservation tours as awards.
(17) Fire prevention.
(18) Recreation development (outdoor good manners, cookery, water safety, gun safety).

Project Ideas—Soils

(1) Control of water erosion (cover planting, grading, sodding, mulching, etc.).
(2) Soil testing (analysis, treatment).
(3) Soil survey and determination of land use according to its best capabilities.
(4) Use of winter cover crops.
(5) Use of mulch and stubble mulch tillage for erosion control.
(6) Farm pond improvement.
(7) Stream and shoreline stabilization.
(8) Wind erosion control (shelterbelts, windbreaks).
(9) Field border plantings (for equipment turn arounds and wildlife).
(10) Hedgerow and living fence development.
(11) Soil improvement (crop rotation, application of lime and fertilizers, and use of organic materials).
(12) Cooperate with Soil Stewardship Week.
(13) Development of compost.
(14) Land judging.
(15) Development of grass waterways.
(16) Development of terraces and contours.

Project Ideas—Water

(1) Farm pond development.
(2) Farm pond improvement (watergaps for stock, fencing, protection of cover on the catchment basin).
(3) Water control devices for streams.
(4) Water testing.
(5) Survey of watershed.
(6) Improving spring sites.
(7) Fencing and watergaps along streams and rivers.
(8) Drainage of periodically flooded cultivated lands.
(9) Pollution control.
(10) Demonstrate:
  (a) Stream silt load determination (be a mud detector.)
  (b) Rate of absorption of water in different ground cover.
  (c) Freezing and expansion of water.
  (d) Evaporation of water.
(11) Mechanics of irrigation.
(12) Study of water laws.
(13) Field trip—water from its source to the tap in the home. Sewerage and other refuse disposal systems that avoid pollution.

(14) Rain making.
(15) Snow survey.
(16) Flood forecasting.
(17) Stream bank stabilization.

Project Ideas—Trees and Other Plants

(1) Tree planting.
(2) Tree and plant identification.
(3) How to preserve plant materials.
(4) Collection of seed and fruit, leaves, wood samples, etc.
(5) Insects, effect of treatment and identification.
(6) Diseases, treatment and identification.
(7) What the wood of different tree species is best used for. (Make a wooden product.)
(8) Wood preservation (treatment of fence posts, and painting).
(9) Fencing woodlots (to protect reproduction).
(10) Thinning and pruning (timber stand improvement).
(11) Fire prevention.
(12) Fire control.
(13) Tours to aboretums, tree farms, forest products industries, fire towers, etc.
(14) Methods of propagation.
(15) Grass identification plots.
(16) Development of cold frames, hot beds, greenhouses.

Project Ideas—Minerals

(1) Study the geology of your county and State.
(2) Make a rock and mineral collection from your county and from the important mineral deposit of your State. Identify and show uses and products.
(3) Outline methods on your farm used to preserve and conserve products derived from our mineral resources; also describe how mineral resources help to preserve other natural resources.
(4) Study the trace elements and their importance to agriculture.
(5) Demonstrate uses of minerals beneficial to farming.

Project Ideas—Climate

(1) Make a weather station to record the various elements of weather that collectively produce the climate you live in.
(2) Study relationship of weather cycles and their limiting factors on crops.
(3) Rain making.

(4) Anti-air-pollution methods.
(5) How can the precipitation factor of weather be modified by tree wind-breaks?

Our sub-group has contacted representatives of the Geological Survey and Weather Bureau and they have shown interest in helping us develop project ideas in the areas of minerals and climate. They are Mr. Chalmers Cooper, U. S. Geological Survey, Phone Code 183, extension 3083.
Mr. Norman Hagen, U. S. Weather Bureau, Phone Code 1252, ext. 456.

Project Ideas—Wildlife

(1) Habitat improvement (develop the required food, cover, and water to produce optimum numbers of desirable animals in an area).
(2) Manage a farm pond for fish (fertilize, control weeds, fence, regulate numbers of fish by species, fish for food and recreation, etc.).
(3) Wildlife controls (by removing any one or more critical elements of the habitat required by a nuisance animal, trapping, etc.).
(4) Manage the environment for production of wild fur-bearing animals on the farm.
(5) Harvest and market wildlife furs.
(6) Landscape your yard with plants that are both beautiful and at the same time attractive to songbirds. (Supplement this with feeding stations and drinking water.)
(7) Do a life history study of an animal.
(8) Identify and collect sign or evidence of wildlife on your farm.
(9) Improve the quality (by aeration) of water in slow moving streams by building log dams, deflectors, etc.
(10) Homes for wildlife (build nest boxes for squirrels, woodducks, and songbirds)."

The committee has as members and consultants some of the most outstanding resource people available.

2. The Regional Resource Conference for Senior 4-H Club Members at Fontana Village, North Carolina. This event attracts more than 300 4-H Club members and adult leaders from seven states for an intensive study of the region and its resources. To give you a better idea of this significant event, I cite an article, "Broader Horizons for 4-H Work," which appears in the February issue of the Federal Extension Service Review. It reads:

BROADER HORIZONS FOR 4-H WORK

"Back in 1956, some of the sponsors of the first Tennessee Valley Regional Resource Development Conference for Older 4-H Youth were skeptical about its success. Now they would quit sponsorship as soon as a youth would quit courting the attractive daughter and only child of a middle Tennessee farmer—one who owns a 500-acre farm all clear!

"The seven States of the Tennessee Valley mixed together generous helpings of the cream of their senior 4-H Club members at Fontana, N. C. Some 200 boys and girls took a clear-eyed look at their natural and human resources and came up with some ideas about their own responsibilities and opportunities.

"Plans are now well underway for the third annual conference. Fontana Village, surrounded by inspiring forest, water, and mineral resources, will again be the site.

"C. B. Ratchford, assistant extension director of North Carolina, is chairman of the 1958 planning committee. It includes representatives of the cooperating State extension services, and the other two sponsoring groups—the Tennessee Valley Association of Test-Demonstration Farm Families and the Tennessee Valley Authority. You can see that this is an excellent example of inter-extension, inter-agency as well as inter-state cooperation.

"How did this idea originate? Many people have been concerned about the depletion of the human and natural resources of our region—movement of youth off farms, migration of people to industrial centers in other areas, a general lack of appreciation for the physical and educational resources of the region; failure of older boys and girls to continue in 4-H Club work; insufficient recognition for those who stayed with club work but failed to win national honors. These and many related factors were of serious concern to our agricultural leaders. The problem certainly was formidable.

Recognition of Resources

"One leader in Kentucky explains it this way: "If any area or State is to fully develop its resources for the betterment of its people, some program must be initiated which will first cause the people to recognize these resources." As a result, Kentucky has developed a State-wide 4-H Club project in resource recognition.

Conference ideas crystallized at a meeting held in Chattanooga early in 1956 and a committee was named to represent the sponsoring agencies. Their job was to develop plans for a conference to include 4-H Club delegates from valley counties in the seven States in the Tennessee Valley region.

"The following excerpts from the announcement illustrate some of the highlights of the first conference.

"The 4-H members attending will spend 3 days at one of the most popular vacation spots in the region. They will learn about the resources of the Tennessee Valley and the entire South; problems and opportunities in the area; and possibilities for developing their skills and talents to take advantage of the area's opportunities. They will visit and work with 4-H members from other States, and take part in discussion, workshops, and recreational activities.

"One boy or girl from each county in the Tennessee watershed is eligible to attend. (Now all States can send two delegates per county). Delegates must be over 15 years old, have outstanding leadership abilities and good project records, and agree to report on the camp to other groups after they return home."

"Officers and directors of the Tennessee Valley Association of Test Demonstration Farm Families promote the valley-wide conference of 4-H boys and girls. The Extension Service in the seven States and the Tennessee Valley Authority help plan, organize and conduct the conference and use it to promote the development of the Tennessee Valley and its people.

"What benefits have accrued? Let's look at some of the comments.

" 'In evaluating this encampment, I believe that it is a phase of club work that we have failed to cover in the past. . . . Many of these boys and girls had not been district or State winners and therefore might not have had an opportunity to prove their leadership.'

" 'We feel that the conference provided one of the best incentives for older youth to continue 4-H Club work—to learn more about our region. Words cannot convey the closeness of fellowship and mutual understanding that developed among the youth of the seven States as we studied and played together and discussed our mutual interests.'

" 'This opportunity if continued will provide a very effective method of fighting the increasing problem of youth delinquency, which everyone knows is due partly to lack of properly planned and supervised worthwhile activities for youth.'

"What are these comments about? The first year, 1956, the senior 4-H'ers presented skits on improved fertilization and soil management, use of electricity on the farm, community development, development of leadership, spread of better farm practices, use of resources, and cooperative action.

In 1957, topics developed by State groups for discussion included forestry; water (rainfall, transportation, industrial, irrigation); recreation; electric and atomic power; human resources; rural organizations; agriculture (livestock, crops, soil management, fertilizer, and conservation); industry and commerce.

Possibilities of Area

"The program includes inspiring talks by leaders from the area. There has been no trouble in obtaining such speakers as an editor of a large southern farm paper, the public relations director of a leading southern insurance company, a member of the TVA board of directors, deans or directors of agricultural colleges, and a college president. Speakers point up the possibilities in the area and otherwise inspire the youths. Leaders who attend hope that the speakers will tip a few wavering 4-H youngsters over the brink toward the conviction that they must have more education with college the next step.

"As for the look ahead, we feel that this pioneering effort is highly significant. It shows how various interest groups can work together to support 4-H Club activities. It also illustrates an approach to a broad field of related subject matter on the part of older youth—rather than dealing with narrow project fields.

Significantly, a national 4-H Club development committee has been formed on the use and conservation of natural resources. Its approach is very similar to that of the regional resource conference. They both deal with plants, animals, minerals, soils, water, and air, and their relationships to human resources. They both are demonstrating the values of cooperation between agencies, States and subject matter fields in the development of the greatest resource of all—man. They are truly making broader horizons for 4-H Club Work!"

Yes, broader horizons are ahead as we in 4-H Club work join hands with all organizations and individuals who desire to constructively practice resource management.

DISCUSSION

VICE-CHAIRMAN PRITCHARD: Do you believe it is possible to glamorize the conservation program of the 4-H to the same degree we did with the livestock programs and various other competing facets in connection with our young people?

MR. FOSTER: There is every reason to believe that we can do just as good a job, perhaps better. At breakfast this morning we were talking about the tremendous potential that this study of wildlife has for boys and girls, and so this thing certainly indicates great possibilities for us as we get going—boys and girls studying and playing together—there is just as much glamor in resource conservation as there is in anything we engage in.

MR. WADE [Des Moines, Iowa]: What are the 4-H people doing in their conservation program to awaken the deep interest in natural areas and in wilderness areas?

Over the past years I have followed the course of the program closely and, reluctantly, I have thought that there might be a weakness. I was wondering if anything could be done to perk up that part of the program.

MR. FOSTER: Come down to Camp Woodley in the middle of Tennessee and you will get all the wilderness you want. There is a good deal of controversy here, but we have everything from camps meeting on the college campus—which some people say isn't camp at all—to Camp Woodley. If you will come down there, we will show you some real wilderness.

FUTURE FARMERS LEARN CONSERVATION

JERRY LITTON

Past National Secretary, Future Farmers of America, Chillicothe, Missouri

Future Farmers of America represents a group looking toward the future. This group stands for 380 thousand farm boys in the nation who are looking with confidence toward the future of farming. This is sometimes difficult in sight of the fact that our water table is dropping by great degrees, and our top soil is rushing into the ocean by the tons every day.

These boys realize that we have lost 282 million acres of valuable farm land in the United States during the past century. Each day, as they ride to school on their way to vocational agriculture classes, they see that they will have considerably less soil than their fathers. It looks to them like a great epidemic—an epidemic of soil depletion and erosion. As the school bus rolls along the highway, the boys look out the windows at the empty rural churches, vacated farm homes, broken down fences, and weeds growing where corn had once thrived. As the bus comes to a halt, these boys, in their coveted blue and gold jackets, walk to their ag. classes determined to bring a halt to this great epidemic that is eating up the very life line of America.

These boys are proud to be a part of the largest farm-boy organization in the world. Their active membership in forty-eight states, Hawaii, and Puerto Rico totals more than three hundred and eighty thousand. Their active, honorary, and associate membership exceeds two million. Since the future farmers of today will be the farmers of tomorrow, it is up to them to conserve our natural resources. They have gallantly accepted this challenge.

You might be interested in knowing how these boys have accepted this challenge. A letter was sent to several state supervisors of vocational agriculture asking the question, *"How Can Vo-Ag Help Soil Conservation?"* A number of replies were received, not only from the state supervisors, but from many teachers and students who had been asked to reply. In fact, more than three hundred letters were received and over one hundred different ways were reported. Here are a few answers:

Minnesota	"My course of study includes fifteen class periods each year on conservation." (That means that each year that group of FFA boys spend three weeks studying conservation.)
Texas	"All of my boys are writing speeches on conservation topics for our FFA public speaking contests." (This is being done in hundreds of FFA chapters throughout the United States.)
Missouri	"Our FFA Chapter operates a conservation experiment with the help of a local cooperative and the soil conservation technician." (Many chapters have such experiments.)
New York	"Our FFA Chapter has a special letterhead publicizing soil conservation." (This shows that they are vitally interested in conservation.)
California	"Our FFA Chapter presented a high school assembly program on conservation." (This is done not only in assembly programs, but in many cases, for radio audiences and civic club meetings.)
Kentucky	"My FFA Chapter prepared an educational exhibit on conservation for our state fair." (Thousands of people witness these exhibits each year.)
Virginia	"This year my FFA boys planted forty-five thousand trees on their home farms." (The FFA boys in Virginia last year set out over one million seedlings.)
Oklahoma	"I worked with the soil conservation technicians in mapping and developing the farm plan on the farms of each of my students." (You will find that most chapters work very closely with their soil conservation districts.)

This should give you an idea of how the FFA boys work on a local level to conserve our natural resources. I might cite a specific example. The FFA, Soil Conservation Service, and Wildlife League in Boone County, Missouri, teamed up in a teaching-application program that has put soil conservation plans on thirty-six farms in their county. More than that, the program is making conservation farming a way of life for hundreds of Boone County boys who may never have any experience with any other kind of farming. Parents, too, are now more enthusiastic about conservation work where some were reluctant at the start.

FFA chapters throughout the nation have put special emphasis on conservation. As a result, the members of FFA practice conservation on their own farms. I might have an example of a FFA boy in my own state of Missouri. Charles Keller, a seventeen-year-old lad who is farming with his mother and older brother at Palmyra, Missouri, has taken over the conservation tasks on the six-hundred-eighty-acre home place. This is Charles's senior year in high school, and already he is one of Missouri's outstanding young soil conservationists. A long list of conservation projects, including the terraces and ponds, represent Charles's accomplishments and trace back to his first year in high school. "In vocational agriculture," he said, "we learned the importance of conserving soil and water, as well as the methods that could be used." Since then, he's furthered his knowledge with extensive reading, through the FFA, and through the personal guidance of SCS workers. Many people now have come to associate Charles with his bulldozer or his grader. This youth, while in FFA, has spent countless evenings after school building terraces, ponds, waterways, and clearing some twenty-five to thirty acres of land. Saturdays have also been devoted to conservation. Let us look at his four years in FFA. His first year he cleared five acres of land and built a pond. The following year he built two ponds, two waterways, a half mile of terraces, cleared four acres, and filled gullies. His junior year he built one pond, two waterways, one mile of terraces, diversion ditch, cleared five acres, and filled gullies. His senior year—one pond, three waterways, one mile of terraces, diversion ditch, five acres cleared and gullies filled. This year's work brings the terracing total up to three miles and the waterways, completed, up to seven. His present FFA soil conservation project is a pond that is being developed as a wildlife area.

It is true that all FFA boys do not have conservation records like this, but there are a great many that do. If I were to read the records set by the FFA national winners in Soil and Water Management, some of you would hesitate to believe high school boys could accomplish so much in the field of conservation.

You can see by now that on the local level there is a great deal of interest in conservation. The Future Farmers of America are also interested in conservation on a state and national level. Let me give you a few examples:

1. Our National FFA Calendar saluted soil conservation as it showed a picture of Vo-Ag boys studying conservation practices. This calendar was placed in homes and businesses throughout America.
2. The National FFA Foundation sponsors awards totaling six thousand dollars annually for boys who do outstanding work in conservation. National winners last year came from Iowa, West Virginia, Washington, and Texas.
3. Approximately thirty states have land judging contests for FFA members. When I was a junior in FFA, I was a member of my local land judging team. As a member, I had an opportunity to judge different soil types over most of Missouri.
4. One state reports the development of a State FFA Conservation laboratory in their state camp.
5. The Oklahoma Association of Soil Conservation Districts in cooperation with their State FFA Association is sponsoring a state conservation contest among their four hundred and three FFA chapters and seventeen thousand state FFA members.
6. The FFA public speaking contest is one of the highlights of our National Convention. The elimination starts at the local level. From there we find elimination contests in the sub-district, district, state, regional, and finally the national finals. During the past four years, sixteen of the twenty national winners in this FFA public speaking contest spoke on topics relative to conservation.

These are only a few of the many conservation activities carried on by FFA chapters and sparked by enthusiastic teachers of vocational agriculture. The real challenge is that our teachers and students in FFA are aware of the conservation problems which exist on their farms and in their communities, and that they effectively use available technical, financial resources in solving them.

''Learning to do by doing'' is the motto of the FFA. Future Farmers throughout America are learning conservation by practicing conservation on their home farms. The twenty fourth Psalm states: ''The earth is the Lord's and the fullness thereof.'' The Future Farmers of America are learning to preserve and protect the Lord's land.

DISCUSSION

VICE-CHAIRMAN PRITCHARD: Jerry, I am sure that the reaction of the audience tells you that your paper has been well received. A few years ago I heard one of Jerry's fellows speak on a program five minutes in advance of the Governor of his state and for the remainder of the evening I felt quite sorry for the Governor. I am sure that the other distinguished speakers on the program here this afternoon wish that they were twenty years of age and could be in Jerry's position.

It is a tribute to this meeting to have you with us and take your time from your classes at the University of Missouri to appear before this conference. We are indeed grateful and it is also a tribute to the organization that you represent.

MR. RAY LANE [Illinois]: There are spots where I am afraid that there is not much activity yet, and so, how are we going to get teachers to push the boys along or how are we going to get those spots alive?

MR. LITTON: We are working on that at the present time. As I have pointed out, the Future Farmers Foundation puts out six thousand dollars each year in awards for soil and water conservation.

Of course, there has been little or no activity offered in some schools. I will put it this way, if we have a Future Farmer Chapter and they have beef cattle breeders in that area and who want the members to work there with them, they will then contact them and help them get their chains started. Further, if the people in wildlife conservation in that area want to help the chapter, then I think that there would be a considerable amount of activity. In other words, good local leadership is the answer.

CHAIRMAN FEIST: Jerry, I want to congratulate you on your fine talk. It was an inspiration to all of us working with youth.

EDUCATION FOR FUTURE BIOLOGICAL SCIENTISTS

OSWALD TIPPO

Chairman, Committee on Education, American Institute of Biological Sciences, and Chairman, Botany Department, Yale University, New Haven, Connecticut

It is obvious that in the few minutes allotted to this paper I cannot give an exhaustive and comprehensive treatment of the subject "Education for Future Biological Scientists," since necessarily this would require detailed consideration of education in the elementary school, high school, college and graduate school. I shall, therefore, have to content myself with a few random comments and observations on education at the several levels.

With respect to the elementary school, it is being increasingly recognized that more training in science should be given in the early grades, for the children in these early years have a very natural curiosity which provides an ideal situation for the awakening of interest in science. This, of course, requires adequately trained elementary school teachers. This is not an easy requirement to meet since the teachers must be trained in so many different fields of science — the several physical sciences and the various biological sciences. It would appear that the early grades are ideal for the introduction of what used to be called "nature study." With a little encouragement from teachers and parents, these young students will very readily take to the collection of plants, rocks, insects, snakes, etc. Such collecting activities lead very logically to the study of life histories and ecological relationships of organisms. Trained teachers can recognize at this early stage the gifted child and give him special encouragement. They can encourage such students to build up collections, to make observations in the field, and to maintain aquaria, terraria, and similar groups of living organisms. Such children can be stimulated to read in the field of science. It is from such field studies, such encouragement, and such reading that many a scientist has received his initial impulse to select science as a career. Finally, it would be well if the study of foreign languages were introduced in the elementary school. Again the child in these early years is especially receptive to such study.

Turning to the high school, I think most people are convinced that we should eliminate some of the fads and frills which have accumulated within the high school curriculum, and instead concentrate on the essential subjects. For those preparing for college, I would suggest the following program: (It may not always be possible to follow this ideal program but I think it would be helpful to have such a model curriculum in front of us as something we should strive for.)

1. Four years of English, including grammar, spelling, writing, speaking, literature.
2. Four years of foreign language study (preferably this should be the study of two languages, one of which may have been initiated in the elementary grades.)
3. Two years of history.
4. Four years of mathematics.
5. One year each of chemistry, physics and biology.

It is recognized that many good public high schools and private preparatory schools have such a curriculum. Yet, it is shocking to observe how many students reach the colleges and the graduate schools without a foreign language and with little preparation in mathematics, not to mention deplorable training in English. The challenge of the Russians has emphasized once again the need for a complete change in the intellectual climate of the secondary schools. Hard work must be made respectable again. High school students as well as their parents must recognize that secondary school students must spend two or three hours each evening on homework. High standards of competence and achievement must be established. Those who do not measure up to these standards should be failed. Although I personally am not in favor of using the summer period for formal summer classes, I would advocate that all high school students be required to read eight to ten books during each summer vacation.

Turning specifically to the high school biology course, I will first call your attention to the necessity of having a teacher in this subject who is specially and broadly trained in the biological sciences. All too often high school biology is taught by the football coach or the physical education teacher or someone else not specifically trained in biology. Naturally the subject has suffered from this sort of teaching. All too often the high school biology course is based almost exclusively on the reading of a textbook, whereas a good secondary school biology course should involve laboratory work and field experience. In the past few years I have had the opportunity to examine some two or three dozen high school textbooks; as a whole, I find them full of scientific errors and very much out-of-date. In addition, I find that they lack balance. Some of them concentrate much too heavily on the human body and human physiology; they are woefully inadequate in the field of botany. After all, biology is a study of *both* plants and animals and so any course in the biological sciences which neglects plants cannot claim to be biology. Plants occupy such a basic position in nature that we can ill afford to neglect them. They are the only organisms which are able to take the carbon dioxide of the atmosphere and water of the soil and manufacture food. All animals, including human animals, are dependent upon plants. Therefore, it would seem basic that we study this process of food manufacture or photosynthesis. Then, too, many biological concepts can be introduced with greater effectiveness by using plant materials. And so I think we need to bring high school textbooks up to date, and we must see to it that they present a well-balanced treatment of the biological sciences.

It is my opinion that our educational system would be vastly improved (specifically the high school program would be made more rigorous) and higher standards would be maintained, if all colleges, public and private, were to require entrance examinations. The tremendous increase in young people who are seeking admission to the nation's colleges and universities has already caused an increase in the use of the entrance examination and I believe that this practice will spread in the years ahead. In some of our private universities four to five thousand applicants are taking entrance examinations for a thousand places in the freshman class. There is every indication that competition for available places will become even more keen in the next decade. It seems only common sense to screen our candidates and accept only those who are prepared for college work.

Turning to the colleges, I think most of us will agree that the task of the undergraduate college is to produce a liberally-educated man—be he a biologist, a chemist, an historian or a student in some other field of learning. With so much pressure developing for the improvement of science teaching in the schools and colleges, there is some danger that the pendulum may swing too far, that biologists and physical scientists will concentrate too much in the fields of science to the detriment of their education in the humanities and social sciences. However, what this country needs is not narrowly-trained technologists or scientific robots, but thinking men who are not only scientists but men of culture who recognize human values. What do we mean by the term "liberally-educated man"? One of the best and most complete definitions which I have read in recent years is the statement made in *General Education in School and College.*[1] "The terms which describe this paragon of perfection (the liberally-educated man) are almost as familiar to educators as the phrases of Jefferson's Declaration. The liberally-educated man is articulate, both in speech and writing. He has a feel for language, a respect for clarity and directness of expression, and a knowledge of some language other than his own. He is at home in the world of quantity, number, and measurement. He thinks rationally, logically, objectively, and knows the difference between fact and opinion. When the occasion demands, however, his thought is imaginative and creative rather than logical. He is perceptive, sensitive to form, and affected by beauty. His mind is flexible and adaptable, curious and independent. He knows a good deal about the world of nature and the world of man, about the culture of which he is a part, but he is never 'merely well-informed.' He can use what he knows with judgment and discrimination. He thinks of his business and profession, his family life and his avocations as parts of a larger whole, parts of a purpose which he has made his own. Whether making a professional or a personal decision, he acts from maturity, balance, perspective, which comes ultimately from his knowledge of other persons, other problems, other times and places. He has convictions, which are reasoned, although he cannot always prove them. He is tolerant about the beliefs of others because he respects sincerity and is not afraid of ideas. He has values, and he can communicate them to others not only by word but by example. His personal standards are high; nothing short of excellence will satisfy him. But service to his society or to his God, not personal satisfaction alone, is the purpose of his excelling. Above all, the liberally-educated man is never a type. He is always a unique person, vivid in his distinction from other similarly educated persons, while sharing with them the traits we have mentioned. A liberally-educated man demands freedom. 'We call those studies liberal,' wrote a Renaissance educator,

[1]General Education in School and College. Harvard Univ. Press, Cambridge. 1952.

'which are worthy of a free man' . . . and we might add today, of a free society. Education designed to free individual human beings from the limitations of ignorance, prejudice, and provincialism makes sense only in a free society and can flourish only within such a society. By a free society we mean one based on the belief that individual persons are ends in themselves, that men are reasonable beings, equal in rights, and that governments exist only to foster their freedom. When totalitarian dictatorship triumphs in the modern world, truly 'liberal education' is the first object of attack, since it is one of the most obvious bulwarks against the brutalization and atomization of the individual. To put the matter another way, a democratic society can never develop if the individuals composing it are merely specialists with no significant knowledge or beliefs held in common. The only way to organize a society of pure experts who have little or nothing in common with each other is through a dictatorship. On the other hand, the ideal democratic society, if there were one, would see to it that its specialists were liberally-educated men. Liberal education and the democratic ideal are related to each other in a thousand ways. It is not too much to say that they stand and fall together."

One should expect, therefore, that the future biologist or any scientist, for that matter, should be exposed during his college years to such humanities and social sciences as philosophy, history, psychology, political science, economics, literature, fine arts, and music. Conversely, the student who majors in the humanities or the social sciences cannot be considered a truly liberally-educated person if he has not had education in the sciences. I think it is indefensible in this day and age in which science and scientific thought loom so large that some of our colleges of liberal arts still require but one year of a science. It seems to me that it would not be too much to expect that a non-science major take at least one year of college mathematics (including some calculus and statistics), a year of the biological sciences, and a year of the physical sciences. In a slightly different connection it has always seemed an oddity to me that so many of our engineering students leave college with no biology. It would appear reasonable that the individuals who do so much to change the basic landscape with bulldozers and other heavy equipment should know something of the basic principles of biology. They ought to know something about the management of vegetation and something about the structure and functioning of human beings.

Focusing attention specifically on the first course in college biology, I am struck with the great diversity among such courses. I am not one to advocate uniformity but I do feel that some of these courses are subject to criticism. Some of them seem to have a premedical bias because of the large number of premedical students who are enrolled. And, therefore, there is an overemphasis on the human animal, resulting in neglect of such important areas as taxonomy, ecology, natural history, etc. Many of the courses lack field work, which seems to me unfortunate. Too often the biology course is actually a course in zoology masquerading as biology. The study of plants and botany is short-changed. I would plead for a well-balanced course rather than for the course which has a biochemical approach, or an ecological approach, or a morphological approach. Instead it seems to me that the course should include the important principles and fundamental concepts of all the basic fields of biology, such as genetics, taxonomy, evolution, ecology, morphology, and physiology. Similarly the curriculum for the biology major often lacks balance. Some institutions weigh it heavily on the biochemical side to the exclusion of such classic disciplines as taxonomy and evolution. In other institutions, perhaps too much emphasis is place on morphology and taxonomy to the exclusion of the newer fields of biochemistry and genetics. The future biologist must not only be liberally-educated in the broad sense but he must also be well-rounded in the various biological disciplines.

When we come to the graduate school we find that at the present time all too many students enter upon their graduate studies lacking one or both of the required foreign languages. They must use up valuable graduate school time to study languages which should have been mastered in the high school, if not in the elementary school. Because of poor preparation in college or because of faulty counseling, they do not have the necessary basic courses in mathematics, physics and chemistry. Basic training in mathematics, physics, chemistry, foreign languages, not to mention English, are the proper responsibility of the undergraduate college and the high school; the graduate school must put its primary emphasis on individual advanced study and original research.

You may well ask how all these desirable changes are to be brought about. I rather suspect that the whole matter is such a complex and difficult problem that nothing less than a complete reorientation of our national culture and ideals will even come close to improving the situation. Unless the American people develop a real respect for intelligence and the intellectual life, little will be accomplished. Dr. Alan T. Waterman, Director of the National Science Foundation, in comparing research in this country with certain European countries has this to say: ''The moral to be drawn from all this is that the relative strength in fundamental research in the European countries is the result of their genuine respect for learning, for teaching, for fundamental research—an attitude which we as a people have never had to the same degree . . . At the present time, the United States lags behind most other countries—certainly all of the leading countries—in the understanding, respect, and prestige accorded learning in general and science in particular.'' In the words of Alfred North Whitehead: ''In the conditions of modern life the rule is absolute, the race which does not value trained intelligence is doomed.''

Central in all these considerations is the problem of attracting and retaining a larger number of top quality teachers. The blunt, unvarnished truth is that this will require substantial increases in teachers' salaries, doubling or even tripling present stipends. If the American public genuinely wants more and better teachers, it will have to foot the bill. Society *must* be made to recognize that here, as in all things, you get only what you pay for. If you are willing to pay respectable salaries, you will attract and retain some of the best minds. If you continue the present salary levels, you will be saddled with the misfits, the second-raters, the zombies—and perhaps a few dedicated individuals, but not enough. Professor Oscar Handlin writing in the September 1956 *Atlantic Monthly* describes the situation as follows: 'Salary in our society is an inescapable measure of the desirability of a job. There was a time when the schoolmaster stood very well in the community by that standard. Few occupations now rank as low in terms of earnings as teaching. The average annual wage in elementary schools ranges from $3,000 in small towns to $4,800 in large cities; in high schools, from $4,000 to $5,000.' I will spare you the customary comparison of teachers' salaries with those of janitors and garbage collectors.

Recently, the Ford Foundation gave the privately-endowed colleges a shot in the arm by appropriating $210,000,000 for salary improvement. We need similar efforts on a far more extensive scale and at all educational levels. It has been estimated that it will require $15,000,000,000 in the next decade to bring professorial incomes to the level of comparable professions. You will note that this estimate is for professorial salaries only; and leaves untouched the elementary and secondary schools. Beardsley Rumel, New York financier and economist, addressing a Conference of the Association for Higher Education in March 1956, urged that college faculty salaries be tripled. Under his plan professors would be paid up to $30,000 a year, with an average salary of $15,000. Let us hope Mr. Rumel will be as successful with this scheme as he was in introducing his plan for paying federal income taxes in installments. Few teachers are looking with any great glee to the prospect of swelling enrollments in the next few years. However, one of the expected by-products of the tidal wave of students will be that the law of supply and demand will force salaries to more reasonable levels. In any case, establishment of higher salaries at all school levels is an important, if not *the* most important answer to the problem of recruiting better and more teachers.

Equally important and inescapably linked with the salary question is the matter of status or prestige of the teacher, or more appropriately, the lack of prestige. Professor Handlin, in the same article in the *Atlantic Monthly* cited before, has this to say about the status of the schoolmaster: "Americans have fixed the schoolmaster in a lowly status because he has fallen markedly in their estimation in the last fifty years. The lawyer, the newspaperman, and doctor, are active and powerful. *Mr. District Attorney*, Editor Steve Wilson of *Big Town*, and *Medic* get things done. But who can respect ***Our Miss Brooks***, a female eager to be married, but unsuccessful and therefore condemned to remain in the classroom; or her male counterpart, the ineffectual, bumbling *Mr. Peepers?* Such people, incapable of the real work of the world, deserve no more than amused tolerance. 'He who can, does. He who cannot, teaches,' goes the old saw; and the nickname 'the Professor' is used with comic disparagement. The caricature is certainly out of place in a society the welfare and security of which depend on its laboratories and its libraries. It is the product of crass materialism but it is nonetheless widely held; and it determines the American attitudes toward the profession."

The salaries and status of high school teachers will be adequate when *you*, as a father, are ready to advise your own son to go into high school teaching. Adequate support of teachers' salaries in the whole education system is possible but it will require the complete reorientation of national values. When we consider the millions of dollars which are spent for cosmetics, for tobacco, for alcohol, for chewing gum ($271,000,000 each year), for the control of bad breath and yellow teeth, for the elaborate fins on oversized motor cars, and for the salaries of the Elvis Presleys and the Jayne Mansfields, we need not despair about the available sources of wealth. We need only *the will* to choose what is really important for the national welfare.

I would make a special point here that this plea is not merely for the improvement of the lot of science teachers, in high school and colleges, but for *all* teachers of *all* subjects at *all* levels. I think it would be most unfortunate if the current hysteria over Russian science should lead to the establishment of differential pay scales for science teachers and to the development of preferential treatment for teachers of science and students of science. We need to improve and support *all* education at *all* educational levels.

DISCUSSION

MR. BENNETT [Central College, Missouri]: I plan to go into wildlife management and my major is biology. What would you say my minor should be?

MR. TIPPO: It might very well be chemistry or physics, I should think.

QUESTION: If we could substitute a course in ecology on a high school level, then wouldn't we have more students getting a better perspective on the whole resource picture than they are now getting through the teaching of biology?

MR. TIPPO: We ought to have a lot more field work, a lot more ecology in our high school biology courses. Too many of them are just textbook courses. The students do not get out into the field and do laboratory work. I don't know whether I would advocate offering ecology in place of biology. It seems to me that you ought to include some other phases of biology as well, but then the biology courses should have a great deal more ecology than at present.

DR. A. B. COWAN [Michigan]: I wonder if it would not be appropriate to mention at this time that there are universities which are already following the type of program which your speaker has outlined and that they are making a very determined effort and have been for many years to produce the type of man that he described in his speech.

MR. TIPPO: Yes, this is certainly true, and I tried to indicate in my talk that there are many high schools which are doing the kind of thing; which I advocated as well as many colleges and some graduate schools. Unfortunately, there are too many in which this is not true.

MR. KABAT [Wisconsin]: I wonder, inasmuch as we are dealing with a cold, realistic world, that it might not be advantageous to make some estimates of the cost of education and the handicaps imposed on the person who goes on to the Master's degree as far as the remuneration he must get to offset this financial incumberance involved in the college education and the advanced degrees. I do not believe that I have seen any projection of what it costs in the way of not just fees and books, but the sacrifice of earning time.

MR. TIPPO: Of course, what you say is certainly true, and I have tried to emphasize those points. The cost of education is going up. I cannot supply the figures that you asked for but then I do know that in some of the private colleges it costs about $3,000 to $3,600 a year to educate one student, and the student, of course, pays something like $2,000 for this. In the next decade I think you will see that these tuition rates are going to go up rapidly and that eventually the student will have to pay $3,000 each year.

MR. SHOMON [Virginia]: I am in complete sympathy with the speaker and his remarks this afternoon. However, I would like to ask, what sort of recommendations could you give state people as to how they are going to reach the college administrators and the state superintendents of public instruction with the thoughts that you have given us?

MR. TIPPO: That, of course, is the real problem but there are many agencies which are trying to do this. I don't know what I can say other than there are a lot of agencies interested in bringing together the two groups. Of course, articles are also being written.

I might add that it is up to professional people to become more interested in education—to try to get on school boards, to take a more active part in state politics and in the state certification commissions and so on.

CHAIRMAN FEIST: We have now drawn to the conclusion of our program. At this time I wish to thank all of our speakers of the afternoon.

I might say that as we analyze what has been given to us here today that I think you will all agree with me that what is of great importance is the participation of youth in the program on conservation—that youth in our national resources poses a real challenge to all of us.

Our emphasis at this meeting has been on youth. You have seen the opportunity which you have, through youth, to serve conservation and, through conservation, to serve youth.

I say to each of you that this is the challenge and I say that in the years to come let's implement those things that are necessary to meet that challenge.

GENERAL SESSIONS

Wednesday Afternoon—March 5

Chairman: ARTHUR H. CARHART
Author and Conservationist, Denver, Colorado

Vice-Chairman: FRANK GREGG
Executive Director, Izaak Walton League of America, Chicago, Illinois

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THE FIGHT FOR CONSERVATION

THE BLIGHT OF POLITICS, OR CONSERVATION BE DAMNED!

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

Webster's dictionary offers four modern definitions of *politics,* an honorable word that in its original meaning merely meant the science of government. Webster, however, must have known something about conservation issues when he coined definition number four. This speaks of politics in terms of political scheming, factional interests, and partisan rivalry. This is the politics that is bad for natural resources, and Webster's definition, in reverse order, makes a fair outline for a discussion of the wrong kind of politics in conservation administration today.

"Ding" Darling, when chief of the Bureau of Biological Survey, frequently said that the two worst enemies of wildlife were Republicans and Democrats acting as Republicans and Democrats. During the nearly twenty-five years since that time, I have seen little to refute that statement and much to convince me of its wisdom. Partisan and personal politics have wrecked more good conservation programs than all other forces combined.

The use of jobs in conservation agencies to repay political debts, or similar positions in any other agencies requiring the services of technically and scientifically trained personnel, is one of the most pernicious aspects of the American form of government. In selecting men to fill such positions, party bosses usually are more concerned with a man's loyalty to the Party than they are with his qualifications to fill the job. In some states, the two-party system is little more than a myth, and, in these, personnel and programs often continue for many years simply because there is no change in party control of the state government. In many states, however, there is a continual turnover of power between two relatively equal political parties. When this situation prevails, the common practice is to "throw the rascals out" once every two or four years and replace the entire upper echelon of the conservation department with a new set of rascals of the new governor's choice. The extent of the overhaul is governed to some extent by the legal safeguards given the employees through civil service or similar institutions, and somewhat by the number of political friends to be paid off.

The political appointees owe political debts and loyalties and are far more sensitive to outside pressures than career employees in the same positions. In the usual situation where turnover is rapid, the heads of the departments know that they will be through in a couple of years, and so they do nothing. If they do act, they frequently take the easiest course by following the path of least resistance rather than bucking political headwinds toward a sound program.

When such political appointees do evolve constructive programs—as some of them do—the programs usually are thrown out with the incumbent himself in the next "housecleaning" in the state capital. Republicans rarely can see any merit in sound conservation programs initiated by Democrats, and vice versa.

I do not mean to infer that this practice always turns up incompetents. More often than not, the conservation administrators placed in such positions, even in the most politically minded administrations, are men of sincerity who are interested in the resources and who honestly try to do their jobs. Usually, however, when they take over their offices, they are totally unfamiliar with the programs or with the responsibilities of their positions. If permitted by circumstances to remain long enough to learn their jobs, they sometimes become competent administrators, and, in fact, a few of the best fish and game administrators in the business today have come up through this somewhat devious route.

I do wish to say, however, that politically appointed heads of conservation agencies, at best, work under decided handicaps. The administration of fish, wildlife, and all other natural resources requires sound long-range planning and programming. The finest administrators backed by the best biologists and technicians that money can hire can hardly be expected to plan and put into operation long-term programs when they know that their own tenure of office will end with the next state election.

We have a prime example of what partisan politics can do to a career organization in the U. S. Fish and Wildlife Service, which is only now recovering from its devastating bout with the spoils system. The Biological Survey had, since it was founded in 1885, been headed by career scientists, and the Bureau of Fisheries, save for one disastrous experience with the spoils system in the early New Deal days, had been headed by trained fisheries men. When these two were combined in 1940 to form the U. S. Fish and Wildlife Service, the career tradition was maintained. In 1953, all the top positions in this Service were placed in the Schedule C category—in other words, they were made political appointments. The career men holding those positions were down-graded to meaningless jobs of small responsibility and eventually forced out of the Service, if not by actual pressure, at least by personal and professional pride. Morale sank to a low ebb all along the line. Many excellent career employees of long service, with nowhere to go but down, left to take jobs with universities and state conservation departments. Ironically, some of the men were loyal Republicans, but they had never thought of their jobs in political terms. The result was a chaotic four years of inaction, vacillation, and generally unwise decisions. The important position of chief of wildlife research and others equally vital remained on an acting basis throughout that period.

The Republicans have redeemed themselves somewhat in the eyes of the conservationists by the forthright actions of Secretary Fred Seaton and Assistant Secretary Ross Leffler. Under their leadership, the wreckage is being salvaged and repaired, and the federal agency entrusted with the management and restoration of the nation's fish and wildlife services is getting back on the track and is moving forward. It now appears that the Fish and Wildlife Service has reassumed its interrupted tradition as a career agency. It will not regain its old status completely, however, until the Commissioner and his staff are included in the career service.

Among the states, the management of natural resources often is handled in the same way. In fact, it frequently is worse because there quite often is a turnover in the governor's office every two or four years. Where no protection against political raiding exists for conservation personnel, the direct effects generally reach far down into the ranks of conservation officers.

Indiana is not the only state that operates almost completely through the spoils system, but it offers a good example of a state whose conservation administration machinery is a Model-T structure in a swept-wing age. Indiana once could boast of having one of the most progressive fish and game programs in the Middle West, but that was for only a decade. In recent years, the Hoosier State has changed administrative personnel so often that only a confirmed optimist could expect to occupy the director's desk and plan ahead for more than a year or two.

The state forestry program in Indiana is in no better condition. Employees of all conservation agencies in this state are subjected to the vicious political assessment program that compels all employees to contribute to the faction or party in power.

In Oklahoma there has been a similar lack of continuity in the game and fish administration. That state has had five directors in the past fifteen years. Oklahoma, superficially, has had a sound basic conservation organization, and it has achieved much under tremendous difficulties. It has had a commission-form of administration for the past ten years and a director appointed by the commission—both features characteristic of the best in the nation. It fell short of the ideal, however, in several respects. The entire commission could be removed at the pleasure of the governor, and the director could be fired without hearing or cause on a majority vote of the commission.

There were many loopholes in an otherwise sound structure through which a number of potentially able administrators were chucked befor they had time to learn their jobs. In addition, the director often found himself short-circuited in his relations with his subordinates when various commissioners by-passed his office and issued orders directly to his staff. Such a situation, which is not unique in Oklahoma, is dangerous. It can lead only to divided loyalties and poor morale.

Oklahoma voters, by a large majority, in 1956 passed a constitutional amendment which was planned to remove the affairs of the new Department of Wildlife Conservation from partisan political interference. Commissioners now are appointed for staggered terms of office with one vacancy occurring each year, and the director can be discharged only for proper cause after a public hearing. Both moves were steps in the right direction.

Unfortunately, however, in protecting the organization from partisan politics, the state legislature, in its vitalizing act, left the door open for the kind of political meddling which Webster called "factional interests." The Act permits the state legislature to void or negate any rules or regulations passed by the commission, and on its face, it appears to remove power from the governor and place the same power in the hands of the legislature. This definitely was not the intent of the voters, and it looks as though they may have traded one type of political interference for another. Certainly the activities of several state senators in recent months strongly suggest a determined effort to use the department for political purposes.

Factional politics can play hob with state conservation departments, even where there is practically no turnover in political power between parties. The latest example of this can be found in the recent history of the Louisiana Wild Life and Fisheries Commission. For many years, Louisiana was close to the bottom of all states, no matter what standard was used to judge the efficiency or effectiveness of wildlife administration. Under the leadership of the Louisiana Wildlife Federation, the state, in 1952, finally pushed through a constitutional amendment designed to protect the commission from political tampering.

Under the new departmental administration established by this amendment, the status of the Louisiana department rose rapidly. Within a year or two, it was recognized as one of the most progressive in the nation. It had a well-trained staff of biologists, a well-organized law enforcement staff, a fine information and education organization, and a progressive program. Its director, although not a career conservationist, was an able administrator with the ability to seek advice from his informed subordinates before making decisions.

When Governor Long assumed office, he immediately descended upon the conservation department. The director was fired and a new director appointed by a commission packed by the governor through legally questionable tactics. Almost overnight, Louisiana slipped back into the old ways. Game farms, which had been found to be of little value in improving hunting in Louisiana, were reopened, habitat improvement programs and research were curtailed, and the morale of the entire staff dropped. Some of the biologists left to seek jobs in other states or in other fields. Those who remained must compromise their professional ethics to satisfy the whims of political appointees. Public hunting grounds, carefully built up by the previous administration, were closed and converted into refuges for deer and upland game, a practice that has been found to be of little value in augmenting game stocks on surrounding lands.

After this raid, Governor Long immediately began a campaign to make his wrecking job permanent by trying to push through a new amendment which would repeal the constitutional status of the state wildlife agency. Fortunately, the move failed when the governor was repudiated by a three-to-one majority of the voters. Still, however, the commissioners, appointed by Governor Long, are hampered by local and state politics, unable to serve properly the sportsmen of Louisiana. The state's conservation program will be a long time in recovering from the disruptive forces that all but shattered it two years ago.

The present governor of Kentucky removed a competent state forester because he would not play factional politics with his organization.

These are only examples of the many cases of poor administration of natural resources that could be mentioned if time permitted.

A similar situation could prevail in Florida if present proposals for a constitutional revision in that state are accepted by the people. The proposal affecting the fish and game agency would remove the earmarking of fish and game license funds, and would place complete control of both revenues and personnel of the department in the hands of the governor. In other words, the proposed "improvement" in the fish and game department would unquestionably pave the way for a prompt return to the worst kind of a politically controlled administration. Florida got away from that sort of thing a few years ago, and the politicians are making a supreme effort to regain control of the fish and game funds and personnel for political patronage.

Factional politics likewise can occur within a well-organized department to the detriment of the public and of the department concerned. The most common example of this is when commission members are appointed according to political or geographic subdivisions of the state. It is difficult to attain a balanced program on this basis.

Another common failing of many commissioners is that they feel they must meddle in affairs that should be left to the professionals within the department. They insist that their favorite areas receive the heaviest stocking of birds or fish and the lion's share of the output of the state forestry nurseries. Often a single strong appointee to a conservation commission will dominate all of the other members and the entire departmental organization under its nominal control. The fine progress made by the Tennessee Game and Fish Department is in jeopardy at the present time because of domination and personnel meddling of certain commissioners. This is a difficult situation to correct. Usually it can be licked only through pressure on the commission by militant citizens' groups on the outside.

Factional quarrels within the department are more easily solved, but often only after they have done great damage to the morale of the organization. I have examined departments where the fishery men were sniping at the game men, the forestry people were feuding with the soils experts, and the conservation officers were mad at everyone. A strong administrator, backed by an intelligent commission, usually can solve such situations promptly by knocking heads together and by the judicious use of the pruning axe.

As long as mankind exists there will be politics both in the good sense and the bad. Politics in its highest meaning is an indispensable part of the American way of life. In its narrower and less honorable aspects, however, particularly when applied to the administration of natural resources, it is both a blight and a blot on the name of democracy.

In anything as important as the conservation of renewable natural resources to the future of America, party-first politics and petty personal politics have no proper place any more than they have in matters dealing with national defense. In a sense, conservation *is* national defense of the most important kind; for a nation without rich soil, clean water, productive forests, and adequate recreation for its people cannot retain a place of leadership among nations. Soil erosion, overgrazing, and exploitative forest management have destroyed more nations than bombs, shells, and gunpowder.

In order to assure sound conservation programs, political interference, from within or without, must be kept to a minimum. We must select the best trained and most experienced administrators to handle these programs and permit them to work without improper pressure from the office of the governor, from legislative bodies, or from narrow pressure groups among the people themselves. Any sound law should have machinery for removing an incompetent or dishonest administrator from office for due and reasonable cause, but this should not include the way he voted in the last election or the fact that he failed to stock the farm pond of a commissioner or governor-elect.

All conservationists should work to remove the blight of this kind of politics from the management of natural resources. Great progress has been made in this field since the early 1930's when the International Association of Game, Fish and Conservation Commissioners drafted a model law to cover the administration of wildlife resources. The basic elements of the law have been widely adopted and have provided more good management of the resources than any or all other systems yet devised.

The enactment of a law, and the inauguration of a sound program, does not stop the politicians from trying to retain political control of the funds and positions in the department, however. Many states have started such programs only to have resource management fall back into the old ways as soon as the conservationists relaxed their vigilance.

It is and will be a constant battle to get and keep sound, continuous programs going.

DISCUSSION

MR. JOSEPH PENFOLD [Izaak Walton League of America, Washington, D. C.]: We all recognize that the evils of politics are not confined in their effects to administrative attempts at the federal and state levels. You mentioned the importance of informed public opinion and of maintaining proper standards. Would you care to comment on the extension of evil political influences in the ranks of lay organizations which presumably are dedicated to sound conservation objectives?

DR. GABRIELSON: I would not mind answering that question. I have seen efforts of certain groups of politicians and others to get control of conservation organizations. They want to control them, or at least to silence them when there is something coming up that they don't want aired. That is very difficult for local organizations to combat, but I can say that no local conservation organization that wants to retain its identity and independence and its ability to look at things objectively should ever permit a party organization man or an officer of a political party to become an official in that organization. That is one way to hold it down.

I have also known of cases where industries polluting streams have made every effort to get their personnel into the local conservation organizations, not to control their thinking about most things, but to keep them from doing anything to clean up existing pollution, and there isn't any way that can be avoided except by alertness in the local organization. When that situation happens in a local organization, it quickly dies of dry rot.

MR. SETH GORDON [California]: I would like to refer to the model law that Dr. Gabrielson mentioned. I had a small part in drafting that law, and later our organization had a part in spreading it throughout the country through the use of reprints and by having the state divisions and chapters promote the ideals involved in that model law.

There is one point that Dr. Gabrielson mentioned that I think might be emphasized and that is that if you can maintain the continuity of policy through a board or commission charged with that responsibility, then you usually have a continuity of program. The model law made no provision for that particular phase other than to recommend staggered terms for members of boards and commissions.

In California, in 1940, they adopted a constitutional amendment under which the terms of the members of the board of commissioners in California, who are the policy-making and regulatory agency, are not only staggered but are confirmed by the State Senate. Those commissioners cannot be removed from office except by a majority vote of both houses of the legislature. This is one way to stop the turnover in commissioners and to insure continuity of policy at the top level.

WATER POLLUTION—THE SHAME OF AMERICA

JOHN A. BLATNIK

Representative (Minnesota), Congress of the United States, Washington, D. C.

Back in 1875, Mark Twain, in writing about the Mississippi, recalled the name given it by Captain Maryatt, a popular English writer of the day. It was "The Great Sewer."

Most of the noble rivers and streams of our country today are sewers. We have one in our Nation's Capital—the great and historic Potomac.

The United States today is the powerful leader of the free world. Why have we let this condition come about, this condition of water pollution that I have called the shame of America?

As a nation, we have been growing at an ever-increasing rate. In Mark Twain's day our country's population was 45 million. Today it is nearly 172 million. In 1937 it was 129 million. During those 21 years we added to our total population a number—43 million—equal to the entire count of our country in 1860.

And the recent figures for the output of our industrial society are equally impressive. During those twenty years, while our population was increasing by more than 30 per cent, our gross national product was rising . . . from $142 billion to $332 billion (in terms of 1947 dollars) or an increase of more than 130 per cent.

In America today we are striving to live with one another on terms of freedom and equality, and as close to nature as our lost frontier and our crowded and multiplying cities will allow.

During the next decades the United States will become a space-poor nation. More and more people will crowd ever closer together in an environment more confined and degraded by revolutionary machines and processes; and they will create for themselves and their descendants more social, economic, and industrial problems and tensions.

A fundamental element of the natural environment is water.

We are attempting to control the pollution of our streams and rivers. There was a time, not so long ago, when our country was so new and thinly settled that the questions of water sanitation could be left to the individual or to the family. The consequences could be largely ignored, because they were individual, and localized.

This is no longer true.

In today's crowded metropolitan areas polluted water threatens life and health, blocks the expansion of industry, and increases the cost of its products. It is almost as bad as no water at all.

It robs us of recreation and vacation areas which once lost can only be re-created at great cost. It destroys our sports fishing, swimming, and boating.

It forces us to spend large sums of money for elaborate water-supply systems reaching hundreds of miles into the mountains, and for expensive water purification works.

It impairs the value of our property, poisons our shellfish food, kills our fish, birds, and other wildlife, damages our boats, ships, buoys, piers, and waterfront structures.

Water pollution is the shame of America.

Back in 1939 a Yale University study came up with some interesting estimates of the daily personal water needs of the average American. The study allowed a minimum of a gallon a day for drinking, six for laundry, five for personal cleanliness, not counting tub or shower, and eight for the toilet. A bath in a tub would call for another 25 gallons, and a shower five gallons a minute. All, said the report, would probably not add up to more than 50 gallons a day for personal use. Almost twenty years later, a 1957 study of the Council of State Governments put the figure about three times as high—148 gallons a day per person.

The list of new or increased uses for water is almost endless.

Approximately half the surface water and more than half the ground water we use now goes for irrigation. In recent years use of more and more water for irrigation has been spreading from our western to our eastern states.

The comforts and business advantages of air-conditioning have only recently been added to our high level of living. Enormous quantities of water are required for large-scale air-conditioning.

More water than ever is in demand for washing automobiles, the larger windows and porches of homes and the great glass expanses of our modern office structures and public buildings.

Only two among our comparatively new commercial products are synthetic rubber and the synthetic dress fabrics. Both are being turned out in very large quantities. It takes 300 gallons of water to manufacture one pound of synthetic rubber and from 100 to 200 gallons for a pound of rayon.

Not only new products, but technical advances and improved methods in the manufacture of those which have become standard, spell a corresponding increase in industrial consumption of water. A steel mill of today needs 65,000 gallons of water to turn out one ton of finished steel; a textile mill 500 gallons for a yard of woolen cloth; a paper mill 20 gallons for a pound of finished product, a brewery 300 gallons for a gallon of beer; a refinery 10 gallons for a gallon of gasoline. It has been estimated that production of a slice of wheat bread takes 37.5 gallons of water, including that needed for growing the grain; and that to grow each pound of beef a steer will consume about 4000 gallons of water from the trough and pasture.

So it goes. Farms, factories, families; cities, town, villages; schools, laboratories, playgrounds; businesses, hospitals, governments; — all needing, and using, more and more water to produce and enjoy the fruits of American genuis and enterprise.

In connection with water pollution control the word "municipal" is used to include the sewage systems of cities, towns, villages, sewer districts, and institutions.

Today about 100 million of our 170 million people are living in sewered municipalities.

About half the total municipal pollution is now being removed by some form of treatment before it gets into a stream. The other half is going directly into watercourses. If a watercourse is large enough, the bacteria in the water and in the raw sewage itself will in time "eat up" the organic matter in the sewage and it will disappear.

This biological process, however, consumes oxygen. Says a technical writer for the Public Health Service: "When the oxygen is used up, all life that depends upon it dies. Fish, shrimp, crayfish, mussels, clams, oysters, snails, beneficial insects and their larvae, and even certain kinds of plants, are suffocated. Animal and bird life disappears. And a foul stench of death advertises that the watercourse has become an aquatic graveyard."

In spite of great strides made in recent years in cutting down pollution with waste treatment plants, our population and our industries have grown at a rate which has outrun our advances in waste treatment. As a result, hundreds of billions of gallons of raw industrial wastes are being discharged into our streams every year.

In this connection, I came across some recent figures about industrial pollution. The source of the figures is Mr. Edward J. Cleary, executive director of the Ohio River Valley Water Sanitation Commission. He told a recent water pollution control conference in Washington that 37 of our States operate under legislation requiring an industry to secure a permit or approval of plans prior to discharge of wastes into a stream.

"But it appears," he said, "that only half of the industries who are required to have a permit are presently meeting this obligation. And in only three States is it a requisite for an industry to apply annually for review and re-issue of a permit. Only 16 States are interested in the quantity and characteristics of the effluents discharged from industrial plants to the extent that they require a monthly report; four States are satisfied with a monthly report."

Mr. Cleary then asked the question:

"Do not these findings suggest there may be some validity to the charges by conservation groups and others that our administration of industrial waste control can be characterized as something less than positive?"

I most heartily second this question.

At this point I should like to make a personal reference. As many of you know, I had a "small role" in amending the 1948 water pollution control act. It was amended, I think, in ways that improved the old law. My basic reason for taking on this task was my conviction that, for a number of good and sufficient reasons, the job was not being done.

Before the passage of the 1956 water pollution control amendments, pollution in the United States had been discussed, debated, diagnosed, surveyed, analyzed, and condemned wholeheartedly. But little seemed to be done about it. It was like Mark Twain's remark about the weather.

I am talking to conservationists; and they know that water is the last important natural resource that is still being exploited on a wholesale basis. In the old days, our people used to go into a forest and "cut and get out." We have largely the same attitude to our water resources today—Pollute and run if we can to the next river or stream.

What kind of water do conservationists want? They want clean water that is healthful to drink, inoffensive to the senses, safe for industrial and commercial uses, and is the natural habitat for aquatic life of all kinds.

This is the kind of water I want, too.

As all of you know, we have provided Federal protection for our forests; we have Federal protection against exploitation of our soil; there are Federal programs for our game, fish and waterfowl; Federal protection against crime, fraud, epidemics, and many Federal protective devices against crushing economic reverses of our citizens.

And yet, until the 1956 water pollution control act, little was done to protect the people of America from the destructive and dangerous results of water pollution.

Dr. Thomas Parran, former United States Surgeon General, recently told a conference of state water pollution control administrators that to him "it seems strange that action by the Federal Government to deal with stream pollution was not taken until 1948, . . ."

He pointed out that the "underlying philosophy of all the grant-in-aid programs is that the Federal Government has a responsibility for the health of the people (and that) the grants have served to equalize the opportunity for health among the States.''

The new Federal water pollution control act (Public Law 660) reaffirms the prime responsibility of the States in combating pollution, and strengthens state pollution control agencies through financial aid, research and technical assistance. It also gives the Public Health Service enforcement powers to alleviate abuses of interstate streams. A vital part of this legislation is that it provides for Public Health Service and for the states to administer grants to assist communities in getitng out of the pollution mess—as much as $50 million a year for a maximum of ten years.

In July 1956 the first appropriation under the $50 million construction grants program became available, and, after the necessary time lapse, to ''tool up'' the program, the first grant was made December 6, 1956.

Since that time, a total of $95 million for sewage treatment works grants has been appropriated to date—$50 million in 1957 and $45 million in 1958.

The approriations for 1957-1958 will remain available for obligation until June 30, 1959, and, at the present rate of grant awards, these funds will be obligated prior to that date. On January 1, 1958, 8 States had obligated 100% of their grant allotments and 10 others had obligated in excess of 90%.

Up to this time a total of 912 grant offers had been made by the Public Health Service. These grants totaled $75 million and supported an estimated $360 million of sewage treatment works construction. Ninety-two per cent, or 845 of these grants were made to communities of less than 125,000 population.

As of now 640 additional grant applications were being processed by Regional offices and State agencies. These projects would require 67 million of grant funds in support of an estimated $600 million total project cost.

As of now 66 projects had been completed and 380 additional projects were under construction.

This construction grants program is a good start. Authoritative journals such as the *Engineering News-Record* have said that it is working. Yet the fact remains that we need to do more. As. Mr. Roswell B. Perkins, former Assistant Secretary of Health, Education, and Welfare, said during the spring of 1956:

''The blunt fact is that up to now, for the country as a whole, we have been falling behind. Excepting only 1936-39, in no year since

1900 had construction of treatment works provided abatement equal to the increase in municipal wastes. Even more serious is the increasing volume and complexity of industrial wastes reaching the Nation's watercourses.''

The rationale upon which Congress included construction grants in the Water Pollution Control Act was that of a temporary device to help municipalities catch up on needed construction which accumulated during World War II.

These needs were estimated to cost about $2 billion. Removal of this backlog would reduce the load on our streams by about one third—which the States have indicated would be generally satisfactory.

My original proposal provided a billion dollars, most of which was expected to be matched on a fifty-fifty basis. The billion dollars in Federal funds together with the $1 billion of local money would make available $2 billion to take care of the backlog—hopefully in 10 years. New needs including population growth and obsolescence would be handled by the communities themselves.

The Act as passed reduced the total authorization by one-half and changed the matching formula. Congress, however, indicated no change in its intended purpose.

Now let me give you—once again—a few figures about water supply, to put the picture into focus.

It is true that water pollution and its control does comprise a vast, complicated, national problem. But it can be stated briefly in terms familiar to every business man and public administrator; that is, in terms of supply and demand.

The Nation's water supply is fixed but the demand is constantly increasing.

The United States has about 1,200 billion gallons of water available in the ground and in our surface lakes and streams. This fixed supply is maintained by an average precipitation of 8 inches, after evaporation.

Increase of population, expansion of industrial and agricultural production, and addition of new kinds of use account for the constantly increasing demand for water.

In 1900, 75 million persons were using 40 billion gallons of water per day. Today, our 172 million population is using 275 billion gallons. By 1975, an estimated population of 230 millions will require at least 450 billion gallons of water per day.

Industrial production increased by 700 per cent between 1900 and 1950 and is expected to double by 1975, a total of 1,400 per cent increase from 1900 to 1975. Agricultural uses of water for livestock and irrigation have increased by 800 per cent in the past 57 years and are expected to expand another 800 per cent in the next two decades. Other important uses of water include power production, inland transport, conservation of aquatic and wildlife, and recreation. These uses increase with the growth of population, industry, and agriculture.

Surface water provides 85 per cent of all needs and it is in this primary supply that the whole problem of pollution rests. The same fixed amount of water must meet the increased needs. As surface water flows from its point of precipitation to the sea, it is drawn off repeatedly from streams to community water systems or industrial intakes, and as repeatedly is discharged, polluted, back to the stream by municipal sewers and industrial outlets, to be used again by the next down-stream community or industry.

The task of cleaning up our waterways is a gigantic one: the U. S. Public Health Service estimates that about 16,000 municipal and industrial treatment works, costing roughly $9 billion to construct, are still needed. But dollars invested in lessening pollution must inevitably bring tremendous benefits.

By curbing pollution, communities encourage growth: Cumberland, Maryland, succeeded in attracting new industry when it rid itself of pollution. Last year when the town put up a modern sewage treatment plant, a new $40 million industry followed and more factories are on the way. That pollution control boosts property values was demonstrated in the New York City area, where, after a waterfront cleanup, real estate along the Brooklyn Shore Parkway soared 68 per cent.

By not curbing pollution, communities lose in the race for growth and expansion.

Already there are areas of the United States where economic development is being hindered or prevented altogether because of inadequate water supply. Many of these areas are in this condition because of pollution, resulting from the excessive use of the waters for waste disposal. Let us look at some of these areas.

There is the 150-mile stretch of the Holston River between Knoxville and Kingsport in Tennessee which, according to the Tennessee State Planning Commission, is so laden with alkali pollution that industrial site prospects reject its possibilities. The Commission says, "Only a few industries, such as rayon plants, can use streams as polluted as ours."

Then there is the situation in New England where a large company's expansion of production was prevented because the water supply has been impaired because of failure to observe accepted pollution control practices. In fact, the firm contemplated moving from the area on this account and consequently the livelihood of approximately 20,000 people was imperiled! Appreciation of the value of water and a sound water management program could have avoided this loss to a community in an area already undergoing economic decline.

The adverse economic effects of water pollution are not confined, of course, to industrial location. For instance, tastes and odors occurring in the drinking water of Charleston, West Virginia, caused by the improper control of industrial wastes cost more than $37,000 for removal in 1955. This cost is reported to have risen about 700 per cent since 1949, and the 1955 cost was 60 per cent more than the 1954 cost. It is evident from these figures that inadequate waste disposal practices can cause a money damage to the general public, for the water rates reflect the higher treatment costs involved.

Another example of adverse economic effects of water pollution concerns the Potomac River near the Nation's capital. A prospectus offered to the Securities and Exchange Commission in support of a bond issue for a residential development along the river at Fort Washington claimed that swimming facilities were excellent. Because public health authorities regard the tidewater Potomac as dangerous for swimming for a distance of many miles above and below that point, the prospectus had to be modified.

Every American has a right to clean water, today and tomorrow. He has this right because he has a fundamental need for clean water to sustain life, to make and move the goods and services that afford him food, shelter, and play in a rapidly growing, complex and technical world.

He not only has a right to clean water. He must have it when he needs it, in quantity sufficient for all beneficial uses, and where he can use it without injury to his fellow citizen.

As the years go by and we find it more difficult to find standing room, the quality of water—our most precious resource—will be the central fact of our lives. We shall know then, as we are beginning to realize now, that the prevention of river pollution is an absolute necessity, especially in our densely-populated, highly industrialized country—for the maintenance of life, industrial efficiency and the general amenities.

Like crime, disease, and traffic accidents in our increasingly crowded country, water pollution will eventually be brought under control.

Purification of our rivers and streams is bound to involve heavy financial expenditures. In the long run, the cost will be born by the general public through taxation and by price increases in commodities where a manufacturer has to build an expensive treatment plant.

But against this must be set the large sums of money which are presently being spent by water works and industrial concerns on treatment of water from heavily polluted streams, as well as against the growing losses to the millions who engage in outdoor recreational activities.

Let us look for a moment at the recreational picture.

Current statistics on individual outdoor activities and areas of general recreational usage are impressive.

An estimated 50 million visits are made to national forests now, and the United States Forest Service predicts that the visitation rate will increase another 33 per cent by 1962.

National parks and monuments accounted for 50 million recreationists, and State parks accommodated 183 million.

The 1955 national economic survey that was conducted by the United States Fish and Wildlife Service in cooperation with the States disclosed that nearly 21 million persons fished and about 12 million hunted during that year.

Approximately 25 million persons are said to be boating enthusiasts.

Although it should be assumed that these figures represent some duplication in recreational participation, it must be realized that there still are uncounted millions of persons that depend on the out-of-doors for recreational pursuits such as hiking, photography, camping, fishing and bird watching.

Of course, accurate estimates of tourist expenditures are not easy to make, but that they are both substantial and increasing cannot be doubted.

Evidence of the significance attached to such expenditures in the communities where they are made is afforded by a recent survey by the Curtis Publishing Company.

Out of 455 organizations questioned, 275 organizations reported that during the fiscal year 1956-1957 they planned to spend $15,784,390 in promotional efforts to attract tourists and vacationers. This figure contrasts with the $3,603,075 they planned to spend to attract industry.

Clearly tourism has a major economic impact on the industries and communities that serve it.

Industry itself is waking up to this demand for recreation by their workers.

Victor Roterus, Director of the Office of Area Development, Department of Commerce, has pointed out that "never before has management been as interested in the health and welfare of their employes and in the human factors in industrial locations; it has become good business to be concerned about recreational facilities for employees when locating a new plant.''

H. Y. Bassett, Vice-President and General Manager of the Wolverine Tube Division, Calumet and Hecla Consolidated Copper Company, said not long ago that ''recreational facilities are of tremendous importance to most industries; and an active recreational program is rapidly approaching a 'must' in present-day industrial relations.''

Advocates of water pollution control are in an advantageous position as the result of the struggle between proponents and opponents. It is obvious that pollution control provides protection for the limited water supply to the extent that control improves the water quality or prevents its further deterioration. Clearly, this contribution has an economic value. It is valuable not only in the immediate sense of its worth in the current market to meet the increased demand for water but in the sense that it provides for future uses and reduces the necessity of large-scale water developments designed in part to compensate for the destruction of existing supplies.

While the demands for water as a commodity in the sense of its use for domestic supply, irrigation, and in the industrial processes are probably the most vital and important, they are not the sole characteristics of water that make it an economic factor. Almost every one is aware that water bodies in the proximity of residential real estate developments enhance land values. This fact was first demonstrated in the 1924 studies of the pollution of the upper Mississippi River in the St. Paul-Minneapolis area. In that study analysis was made of the effect of pollution on lot sales, residential building, and assessed valuations on both sides of the river. Legislators and others concerned with the problem became convinced through this analysis of the adverse effects of pollution and of the economic benefits to be obtained from cleanup. The metropolitan sewerage district with its elaborate treatment plant was a direct result of the study.

Another example of economic benefits associated with the cleanup of pollution conditions can be seen in recreational uses. Not only is there an economic value to the use of the water itself in this manner but in the vicinity of a water recreational site new economic activity is engendered in the form of motels, restaurants, and stores catering to campers, picnickers, fishermen, etc. The contribution to national income and regional prosperity is evident.

Another example of economic benefit to be derived from pollution control was suggested recently by a psychiatrist who noted the relationship between a clean, cheerful environment and mental health. He was referring to the problems of urban blight and the benefits to community mental health, but certainly clean streams also exert a positive influence in this direction. Old Izaak Walton was the first to state the case for this beneficial aspect of water. and it has been reiterated many times since.

The matter of cost is always important; it may even be a matter of survival in today's world of high-powered missiles and high-powered tensions. Yet costs are a matter of balance and adjustment. The annual appropriations of the water pollution control program—$50 million—would not keep a missile in the air very long.

It is imperative that we keep ahead of Russia in our competition for survival. But there are things we should do because they are the right things to do, not because our neighbor is breathing down our necks. As a matter of fact, Russia claims that the Moscow River in her capital city is free of pollution. I have no way of knowing whether this is true. But one thing I do know, I wish I could say the same thing of the Potomac River in our Nation's Capital. And of Mark Twain's beloved Mississippi.

And of all the rivers and streams in America.

DISCUSSION

MRS. ROBERT BURGANE [St. Louis]: I am just an interested citizen and housewife who came here to hear about pollution. However, I was wondering if anything was being done about air pollution. Our cities are covered with smoke and exhaust gases, the exhaust from cars, trucks and public transportation.

REPRESENTATIVE BLATNIK: I tried to bring the matter of air pollution into my remarks. We do have some areas in which the air has become so highly polluted that it is dangerous to human life. There has been a tremendous amount of work done on determining the characteristics of smog and air pollution and finding how to contain and abate them. Great progress has been made along this line, especially in Pittsburgh and other cities.

The Federal Government has not gone into this much except for some research, but it is a problem that seems to be on the way to being solved on state and local levels with some federal participation.

CHAIRMAN CARHART: Of course, I would like to make one statement and that is that, as a precept with regard to water, the right to use water does not confer the right to destroy its usefulness.

NATURAL RESOURCES GOING OUT THE WINDOW

WILLIAM E. TOWELL

Director, Missouri Conservation Commission, Jefferson City, Missouri

"Going out the window" is a phrase that has developed specific meaning through usage. It implies waste. It signifies the act of throwing things away, never to be regained. The title of this paper, therefore, suggests that we are destroying our natural resources. In case there be any doubt, I think we *are* destroying them. According to the laws of physics, matter cannot be destroyed—only changed in form. But if the new form is not more beneficial to society than the original form, then there is a loss—not to matter, perhaps, but to mankind. At the very best, we are not getting wisest use for the greatest number.

The fight for conservation can never be relaxed, and *we* must direct the fight. Our enemies are greed, selfishness, apathy—and ignorance. Some of the most appalling misuses of natural resources are perpetrated under the banner of conservation. Even in apparently legitimate conservation projects, we may close the windows of waste to open larger doors of destruction. We must consider 1978 as well as 1958; we must consider the whole complex of human use instead of the individual project.

We cannot possibly consider *all* natural resources in the time allotted to this panel; I can only attempt to highlight a few that most demand we close the windows of waste. In our minds we must still reserve room in which to consider long-range effects of atomic radiation, of air pollution and of powerful new pesticides on both man and wildlife. But for now, let us consider some of the windows where the forces of conservation can best stop the wastage of natural resources.

Soil and water are the two most basic resources of life. You and I know this; we have repeated it over and over again. But how many people really recognize the obvious fact that man, no less than all other members of the plant and animal kingdoms, is utterly dependent upon the availability of soil and water in sufficient *quantity* and *quality?* Civilizations and cultures die when these resources are exhausted or even degraded. We need only look back into the history of Northeast Africa or Southwest Asia for the proof. Lands once prosperous are now sterile deserts. Though science today can transform seemingly abundant resources into food, clothing and shelter, — and probably more ways will be found to produce these essentials synthetically — our ultimate survival still rests with water and the soil. We had best not assume that science will save us; science can also destroy us.

Soil resources are going out the window: agricultural production in

America is not geared to the food requirements of the nation, but to the competition for wealth. Subsidies to maintain guaranteed higher prices stimulate greater production—not for food but to add to growing surpluses. Again and again our western wheatlands are lifted by the winds to darken the eastern skies—just to produce crops that are not to be eaten. Acreage allotments encourage the farmer to grow "uncontrolled" crops or force greater production from fewer acres. In any case, our soil is the poorer.

We read that millions of tons of topsoil are deposited in the Gulf of Mexico every year (and you almost can see the earth's passage from your hotel window). Yet what percentage of Midwest farm lands are protected by terraces, contouring and grassed waterways? The size-supremacy of Texas may be threatened by the growing delta of Louisiana (if you'll pardon a minor exaggeration for emphasis), but I think you will agree our soil resources *are* "going out the window."

Water resources, too, are pouring over the sill. One of the few things keeping pace with the population surge of the United States and Mexico, and possibly Canada, is the consumption of water. Water tables drop lower and lower as the demand goes up and up. As water supplies grow less in critical areas, which needs will suffer most? Will the greatest good for the greatest number determine priorities? And who will decide where the "good" and "number" are to be judged? Already these questions are acute in some localities—but they remain unanswered! Antiquated water laws, or the absence of any controls at all, threaten wildlife and recreational interests. Fishing and recreation were ruled out as greatest good for the greatest number at the John Martin Reservoir in Southeastern Colorado. Under the "prior appropriation" doctrine, flood waters stored in the reservoir ***had*** to be released when irrigation demands imposed their "prior" rights. Will obsolete laws influence court decisions and new legislation in states just beginning to face up to their water problems?

Shortages in critical areas and conflicting interests in use are only two phases of our water concern. A growing problem, along with a booming population and industrial expansion, is the abuse of water that makes it unfit for further use—*pollution.* In spite of federal and state pollution control legislation, many streams throughout the nation are simply open sewers. It seems barbaric that in 1958 a civilization such as ours can still foul its nest by dumping poisons into its streams. The water we drink in Jefferson City comes from the sewers at Omaha, St. Joseph, and Kansas City. Municipal and industrial wastes, dumped raw into stream channels, constitute one of conservation's greatest challenges: not only as an enormous public health problem but as a serious waste of fish, waterfowl and recreational resources.

Only a determined fight in the last session of Congress kept pollution control appropriations in the budget. Even a greater fight looms ahead, because the President has told Congress that this program should be discontinued entirely after the next fiscal year—although the bill for navigational development on the wild Missouri River was much higher than the water-pollution money for *all* rivers. For every barge on the Missouri, a half-million people must drink from it. Our fight for water is only beginning. Conservationists will face determined opposition from shortsighted industries and municipalities before the trend is really reversed.

A more insidious situation has become apparent lately, since industry has become public relations conscious. Knowing it dare no longer openly oppose pollution control measures, industry often joins the fight to shape legislation that is so watered down as to be scarcely effective, and conservation wins a hollow victory. By and large, the only forces openly opposed to pollution control are large municipalities which fear tax rises should pollution control become a reality. We can deal with opponents,—but who will save us from our "friends"?

Constant vigilance is required to gain recognition of wildlife and recreation values for the public in flood control, irrigation and hydroelectric impoundments built with that public's money. Government ownership of shorelines has been forcefully advocated by conservationists, just to insure that the paying public may have access to these lakes. Previously federal agencies had adopted a policy of only partly controlling lake shores under flooding easements. Proposed amendments to the Federal Coordination Act of 1946 would require evaluation of wildlife and recreation gains or losses before any new projects are authorized. These amendments would also require appraisal of the effects on these resources for impoundments previously authorized but not yet started. These changes are of utmost importance to all wildlife conservationists — but they will require a fight for the public interest.

In a determined battle, conservationists have so far blocked appropriations for the proposed Bruces Eddy dam on the North Fork of Idaho's Clearwater River. This big flood control-hydroelectric project would stop spawning salmon and steelhead trout from migrating to one of their biggest breeding areas and would flood a major winter feeding range of elk and deer. In 1955 Congress authorized studies of the effect of this impoundment upon fish and game resources but proponents are unwilling to wait for the results of these studies. Some of the impoundment's opponents urge construction of Hell's Canyon dam on Snake River as an alternate to Bruces Eddy that would not be so destructive to wildlife. Basically, this fight is for more than fish and big game — as most such struggles are. It involves major political issues and the battle between public-power and private-power factions. But fish and game conservationists must be ready to rally against this or any other threat to these resources or out the window they will go. Wildlife cannot be isolated from land and water decisions.

Another battle is being waged in the marshlands and in the pothole country to save waterfowl from threatened destruction. Northern nesting potholes are disappearing at an alarming rate under the stimulation of agricultural subsidies so that crops may be raised to go uneaten both in the United States and in Canada. Marshes and swamps along the flyways are being drained constantly for agricultural and industrial developments. The rate of waterfowl habitat loss far exceeds the rate of wetland acquisition by federal and state agencies. Duck and geese are flying out the window because there are fewer places for them to rest, feed and breed. Meanwhile, the places left for waterfowl are under attack by agricultural forces because ducks and geese eat nearby grain—grain already in surplus supply.

We argue among ourselves on how to finance this urgent program of wetland acquisition: that is, how we can supply with the right hand what the left hand is taking away. The need for increased Duck Stamp fees is generally agreed upon, but we do not agree upon a sufficient amount to reverse the drainage trend. It is our job, if we are to promote wildlife conservation, to convince the sportsmen that they will have to pay the costs necessary to preserve these resources. We cannot afford to make this another feeble attempt of "too little and too late."

Wetland needs of waterfowl should receive primary consideration in planning of all large impoundments. The proposed Kasinger Bluff Reservoir in Western Missouri, for example, could become a major waterfowl haven, without lessening its effectiveness for flood control. But multiple-uses and secondary benefits such as this must be recognized and included in the early planning stages of water developments.

It is difficult, and perhaps unwise, to separate these resources actually going out the window from those that are being pushed dangerously close to the ledge. There are constant threats by private interests seeking to gain control of public forests and recreation areas for purely personal gains. Grazing interests never abate their longing to acquire control of federal range lands. Lumbering interests covet all remaining virgin timber under government control. Fish, game and recreation values have to withstand the determined competition of mining claims, oil leases, inundation or the clutch of the military for air fields or bombing ranges. The defensive struggle to maintain a sane balance never ceases.

Forest resources cannot be separated from the soil, from flood control or water storage, from wildlife or recreation. All are interwoven into a complex ecological pattern, and when one thread is broken the whole fabric begins to unravel. But in many ways forest resources, too, are making dramatic exits out the open windows. According to "Timber Resources Review" (U. S. Forest Service—1955), fire is potentially the greatest forest enemy—but in 1952 insects killed seven times as much sawtimber as fire did, and disease killed three times as much. Together these three destructive agents killed nearly 13 *billion* board feet of sawtimber in one year. Perhaps of greater significance is that these losses amounted to 44 *billion* board feet of potential growth.

Even though fire losses in our forests are now greatly exceeded by losses from insects and diseases, this does not mean that fire protection activities can be relaxed. Expansion of fire control efforts is needed everywhere, particularly to areas now lacking organized protection, for fire still remains the greatest potential enemy. But our new challenge is primarily one of organized protection from other forest enemies, principally insects and disease. And I think we must face up to our wasteful methods of forest utilization. Of every four cubic feet of timber cut, one cubic foot is wasted. It goes out the window in the form of sawdust, slabs or usable logs left to rot in the woods.

Still another challenge is the 115 million acres of forest land in which less than 40% of the trees are desirable species. One fourth of our commercial forest area is producing less than half of the timber that this land is capable of growing. In fact, many open windows are draining away America's forest wealth with unspectacular trickles that have cumulative effects.

Furthermore, we must continue to insist upon a correlation of efforts between foresters and wildlife people. The multiple-use—and wise use—of forests is our constant concern.

We have seen several wildlife species disappear completely through open windows: the passenger pigeon, the Carolina parakeet, the heath hen. Other species like the sage grouse and the whooping crane are barely hanging on to the sill, waiting for us to shut the window or to kick them on out.

What are we doing to stem the tide of habitat destruction? Are we going to sacrifice our remaining game because it cannot compete with the modern exploitive agriculture? The Conservation Reserve provisions of the Soil Bank Act and the Small Watershed Program under

Public Law 566 offer great possibilities to slow the rate of habitat losses. Are we taking full advantage of these opportunities? In fact, do we know *how* we can take such advantage? And are we also proposing further measures?

Other means must be found to encourage private landowners to manage their lands for game production. If we do not find some way to aid the farmer in providing beneficial wildlife practices, either wildlife goes out the window entirely or it remains only with those few who can afford to lease private hunting areas and pay for the necessary wildlife management. Unless we find a better solution, commercial put-and-take hunting areas may be the only answer for many sportsmen. The best waterfowl areas and big game ranges will be available only to a financially privileged few. I do not believe that building public fishing lakes and acquiring public hunting areas is enough of an answer for us, either. Our chief responsibility is to maintain wildlife production on private lands, and at the same time make it available for public harvest.

Land use is not the only window out of which wildlife is going. Antiquated views on sportsmanship and game laws contribute to such fallacies as permitting the harvest of only buck deer from herds far outnumbering the capacity of their range. Well-meaning sportsmen abhor the thought of killing a mother deer or her fawn but do not seem to grasp the fact that they will otherwise die of starvation and disease or fall to predators. Nature's harvest is ruthless, but *sure*.

Fisheries management is complicated by a similar problem—major fishing pressure concentrated upon a few favored game fish species. On one of our big impoundments in Missouri, 85% of the total fish *production* is of the so-called "rough" species; yet, the annual *harvest* from this lake includes only 15% of these species. Game fish production suffers from this competition of overpopulated non-game types. But when more liberal methods of harvest are proposed or commercialization is permitted, there is immediate objection by the fishing public.

It is inevitable that some natural resources will go out the window. Progress cannot be made without mistakes; advancement will always cost something. The mere fact that we recognize some of our own inconsistencies indicates progress.

But some of our lost resources represent impure and simple waste. No one can condone waste, although we attempt to justify the squandering exploits of early pioneers and somewhat later industries on the grounds that the supplies of resources then seemed inexhaustible. But today we take our stands—or say we do—against waste for economic or political expediency. We are wise, now; we know that the resources are not unlimited. But waste continues!

Despite our preoccupation with atomic power, satellites, and intercontinental ballistic missiles, our strength—even our lives—still depends upon soil and water, forests and minerals, and upon the plants and animals which they produce. The base supporting everything we call man and his civilization is the raw materials provided by nature; culture is only our ability to use these materials. And the most important culture of all, the one which we can never afford to let escape through open windows, is the organized effort of conservationists to preserve our heritage—which has made possible our prosperity, our progress and our strength as a nation—our natural resources.

I want to make this one last observation. In the struggle today between nations, we say we are "defending our way of life" by spending huge sums in building air bases around the world, in buying loyalties of other nations, in building satellites and warheads, in using all our resources for "defense." Are we heading into a situation where, because of hysteria and fear, we may spend all our *true* wealth, the natural resources? Someone must see that we do not build a Maginot line solely to defend the resources already expended in building it. That *someone*, I think, will have to be us.

DISCUSSION

VICE CHAIRMAN GREGG: I think that we have heard a marvelously concise survey of the renewable resource field and if I may offer an observation it would be that the most remarkable thing about this talk is the fact that it calls every spade a spade.

MR. RAYMOND GREGG [National Park Service]: I plan, when I retire, to live in the Ozarks. I would like to know what you are doing to preserve the streams of the Ozarks.

MR. TOWELL: I can assure you that this is a problem of very great concern to the Missouri Conservation Commission. There are certain Ozark streams, particularly our principal bass streams, that the conservation commission is desirous and determined to protect at all costs. We have a specific policy with regard to any impounding measure. However, we will reserve the decision until we have had an opportunity to evaluate completely any net losses or gains of wildlife resources. I can assure you that on the Current River and some of the similar types, our surveys have heretofore and probably will continue to show that wildlife resources take a decided loss and we will certainly oppose the destruction of those streams.

MR. DON BRADSHAW [Alton, Ill.]: It was brought up recently that from Alton to Cairo, on the Illinois side of the river, there are no wildlife refuges, rest areas or anything of that sort, whereas north of that there are quite a few. I am wondering if this is true on the Missouri side.

MR. TOWELL: I do not believe that we have any designated refuges that far down the river on the Missouri side. However, we do have some areas inland a few miles.

MR. BRADSHAW: There has been considerable talk here in St. Louis about making an industrial site out of the Columbia Bottoms. Several years ago there was a report in the paper that several thousand waterfowl wintered in that area. Have the state agencies working on this conferred with you or asked your opinion about it?

MR. TOWELL: Not to my knowledge, in the last few years. However, I can certainly assure you of our interest and we will be happy to work directly with an adjoining state or with any state agency.

VICE CHAIRMAN GREGG: Would you describe the Engle Military Land Withdrawal Bill as being adequate to protect you from such things?

MR. TOWELL: I would say that the new bill, which has just become law, is a decided improvement. The bill requires that any of the defense services must require Congressional approval before they can take more than five thousand acres for any military establishment.

I can envision that perhaps there might be some possibility of the acreage limitation incurring some losses to natural resources and wildlife but there is such a decided improvement now that we are not worried about such losses.

OUR PUBLIC LANDS: SHALL THE PUBLIC ABDICATE CONTROL?

SIGURD F. OLSON

President, National Parks Association, Ely, Minnesota

This is a question of great importance for these lands, the remnant of the old public domain; the unsettled and at one time unwanted regions of the old frontiers represent close to half a billion acres, or almost a quarter of the total land area of the United States. No longer unwanted or unused, these last reserves of old America are still largely untapped, with scenery representing the most spectacular the continent has to offer. It is no wonder they are the subject of constant controversy.

Almost 99 per cent of this land is administered by three departments, Agriculture, Interior and Defense. The great bulk of it is handled by the Bureau of Land Management, the U. S. Forest Service, Office of Indian Affairs, National Park Service, Bureau of Reclamation, Soil Conservation Service and the Fish and Wildlife Service. Of this acreage the national park system controls almost 25 million, the national forests 167 million, the Bureau of Land Management 178 million, wildlife refuges 8 million, the Bureau of Reclamation close to 10 million, the remainder by Defense and other categories. It is of interest that most of this land is in the West, where it constitutes 54 per cent of the eleven mountain states.

These lands and our attitude toward them are the basis of this discussion. As Americans we regard them differently from any other part of our land ownership. This is a direct aftermath of the days of tbe frontier, when conservation was unheard of, and when there was only one problem, to eliminate the wilderness—cut the forests, overgraze the plains, mine the land, and exploit all natural resources witb complete disregard for the future. Our record of waste during this period of our expansion is unique in the history of the world. Never has an entire continent been so swiftly and ruthlessly exploited. In the short space of three centuries, while wealth and power went to those who had the courage and strength to seize and use what the new country had to offer, an attitude was developed that resources were inexhaustible, and that there must be no interference with private initiative in converting them into dollars.

The history of the conservation movement during the last seventy-five years is a record of the battles to overcome this deeply ingrained belief. Since the 1870s, with the establishment of the first forest preserves and national parks, through the days of John Muir, Gifford Pinchot, Stephen Mather and Theodore Roosevelt, there has been and still is a constant effort to set aside, protect and properly manage public lands in the best interests of the people. A revolutionary concept, it was fought every inch of the way by those who felt the spirit of the frontier must not be violated for fear we would lose our pioneer strength and virility.

This concept is still prevalent, and the public looks with tolerance on those who carry the old banner and move into areas to make a killing. The old "cut out and get out" philosophy is still accepted, just as is the concept that there is no end to resuorces. The average citizen, while he may have heard more in recent years about conservation than ever before, still vaguely links the term with hunting and fishing, Arbor Day, bird watching and wild flower protection. Laudable as all these activities are, the real and basic issues of conservation of natural resources have not really struck home. This has direct application to our public lands. Though the distinction may be self-evident to us, many people today do not know the difference between national parks and national forests, and have no concept of working programs based on the idea of multiple use.

The average urban dweller has little understanding of what is involved, and inasmuch as he still tolerates the idea that natural resources are there for the taking, just as they have always been, our public lands are in jeopardy constantly. The persistence of the old pioneer concept regarding undeveloped country, and its direct carry-over to the relatively unoccupied public lands today, constitutes a threat which will require the utmost in courage and vigilance to control.

Another characteristic of Americans, and one particularly indigenous to all who live close to national forests, national parks and monuments and wildlife reserves, is that these areas belong to them exclusively. It is difficult for anyone living near Yosemite, on the grazing lands of Utah or in the Quetico-Superior country not to develop a sense of personal ownership and special privilege regarding these lands.

I happen to have spent most of my life in the incomparable lake and river country of the Minnesota-Ontario border, known as the Quetico-Superior, have lived in the heart of it for many years. Long before the Superior National Forest became famous as a resort and wilderness canoe country, I knew it well and became familiar with the attitudes of neighbors and friends, especially the chambers of commerce in nearby local communities. The Superior National Forest, it was felt, belonged to the people who lived there. Tourists coming in from the outside did not really belong, and while they left a bonanza of good hard cash, they had no ownership. Washington was far away and administrators coming in were only tolerated. They had jobs to do, and while they were hamstrung by any real knowledge of the country, by and large they were accepted, until regulations began to restrict local activities, especially in the harvesting or use of natural resources.

Then it was the Boston Tea Party all over again. "No taxation without representation. Throw out the foreigners!" While it was not exactly a question of taxation or representation, the basic philosophy behind resentment toward governmental interference was identical. "These easterners don't know the score. Why should they tell us how to run our country when they don't live here and know nothing about it?" The old pioneer spirit was operating again, the fierce holding onto the old freedoms and opportunities, and resentment against anyone who might tell them what to do; an attitude found in the far West, in New England, the South and also in Texas, that no government shall tell people what to do with their land.

Any area remembering the frontier knows the feeling, and its conservation history is a documentation of the struggle of the Federal Government to superimpose restrictions for the broad public good. The most difficult thing to accept in such areas is that national parks, forests, refuges or lands under any similar category belong to all the people; that tourists are not merely visitors, but are enjoying land that belongs to them, land they have a right to protect and use as completely and fully as those who by accident or design find themselves fortunate enough to be living in or close by it.

The history of the preservation and protection of the Quetico-

Superior country, and the threats that have been met there over the years, indicates the part this pioneer attitude has played. It began with a plan for a gigantic power development in the early 1920s that would have inundated most of the border lakes, covering some of them to a depth of eighty feet, destroying shoreline beaches and waterfalls, and making stagnant pools out of beautiful and historic waterways. This was fought for nine years before the International Joint Commission ruled that in the broadest public interest the recreational values of the area must be saved. Who were the proposed exploiters? The old empire builders who looked upon this land as one last opportunity, empire builders backed by chambers of commerce and individuals who might profit by exploitation.

No sooner was this battle well underway before another loomed, the threat of shoreline logging of all lakes, both in state and federal ownership. Who wished to cut the trees down to the water's edge? The local loggers, backed again by the chambers of commerce, pulp and paper companies, and all those who were unable to see the intangible values of the great pines standing tall and straight along the shorelines, just as the voyageurs saw them two centuries ago. All the operators recognized were millions of board feet and dollars coming their way. Settled at last by the enaction of the Shipstead-Nolan Law of 1931, and a similar state law in 1933, the shorelines of this country were saved for a higher use.

The next great threat was the airplane, and again a small group of exploiters, who had disregarded the zoning plans of the U. S. Forest Service for the interior wilderness by building airplane camps on hitherto inaccessible lakes, banded together. They enlisted congressmen, the Airplane Operators and Pilots Association, chambers of commerce and others to combat what was denounced as a violation of basic freedoms as envisioned by the Constitution of the United States. Freedom of Access, the rights of citizens to travel where and how they pleased, to use the country they lived in irrespective of zoning or other uses proposed by government agencies, became the battle cry. Even when the now famous Air Space Reservation was signed by President Truman in 1949, it was violated repeatedly, contested in district courts, the Court of Appeals and finally settled only by favorable action of the United States Supreme Court. Airplane operators, a handful of interior resort owners, only a small percentage of those engaged in recreational business in the area, had made it seem as though all the people were violently opposed.

The battle goes on today, in the attempt by the Forest Service to purchase all private interior holdings in the roadless areas of the

Superior National Forest. Seen as the only solution to proper zoning, protection and control, this program has been and is still being opposed by the same factions who have fought all protective measures during the past forty years. While public opinion generally is now in favor of protection, there is still a small voluble minority who cling to the old adage that wilderness preservation is an infringement of private rights, and that the area belongs, not to the people of the United States, but only to those who live there.

This identical pattern exists in the West today. Anyone who has been familiar with the long battle over grazing rights, the attempt of permittees to secure vested interests in the public domain and eventually complete control, see a similarity in the issues involved. Western cattlemen are no different in their outlook than the people who live in the central lake states. They in a sense, consider themselves pioneers, even though the ranches they work may be financed by eastern capitol. Put a pair of cowboy boots and chaps, along with a sombrero, on even a dude and instantly he is a "rider of the purple sage" with "no law west of the Pecos." The inalienable right of a man to run his cattle where he pleases, and to use his own judgment as to the time to take them off, is not a matter for easterners to decide, but for those who live with the smell of sage and mesquite and have the feel of open horizons and space in their bones.

We are all familiar with the pattern of sanctity of action of the man on the ground, and the furor that can be raised in his defense whenever there is the slightest intimation that his activities as a pioneer might be curbed. Ignoring the rights of all the people who have the same vested interest, it is the so-called "little man" who must not be interfered with.

During the last few months we have been treated to an example of this situation in Utah, where a small and violent minority are attempting to evade the sound management policies of the U. S. Forest Service.

The spark that set off the recent conflagration in Utah was a Forest Service decision to change the number of livestock permitted to graze on 16 of the 916 national forest grazing allotments in the state. The total number of livestock to be permitted on 13 of these grazing allotments would be reduced in the interest of saving the range from overgrazing, and the privilege of running increased numbers of animals was to be granted on three others.

Running true to form in this type of situation, J. Reuben Clark (president of the Utah's Cattlemen's Association, an old time rancher personally affected by the reduction) berated the Forest Service, the

Bureau of Land Management, sportsmen and recreationists, accused the East of providing niggardiy sums for the improvement of national forest grazing lands and spoke of coercive forces against the stockmen.

Immediately thereafter, some of the permittees involved formally appealed the ranger's action. Actually, only eight of the thirteen permittees affected objected to the reduction. As a result of this violent minority, the Utah Cattlemen's Association took up the cudgels to protect the ranchers. Rather, it might be said that the Executive Secretary and a few of the officers took action, resulting in a series of local meetings criticizing the Forest Service, its management policies and personnel. The Utah Cattlemen's 39th annual convention protested the action and was supported by regional groups.

At this meeting, the secretary issued a challenge: "Who will speak for the cattlemen?"

"It is therefore necessary," he said, "that we be in a position to defend ourselves and guide the future in our favor. There are many who would like to speak for and represent the cattle industry. Let's be in a position to show our teeth and speak with authority."

There is a great similarity here to the type of reaction in the Quetico-Superior and elsewhere, a vocal minority of entrenched interests who feel that the public lands, because of established patterns, belong to them and to no one else, and that they should have the right to use them, and perhaps destroy them, with complete disregard for the national interest.

It must be remembered that only 21 per cent of all the range cattle in Utah graze on national forests during part of the year, that more than 90 per cent of the annual forage requirements of the state's range cattle and sheep come from lands other than national forests, that only 13 of the 916 state grazing allotments were affected by the reduction and that appeals had been filed on only 8 of these.

It must also be remembered that in the grazing part of the West possibly the most important product of national forests is water. In Utah, 85 per cent of the water for community, agricultural, industrial and military needs arises in national forests. The relationship between floods and overgrazed watersheds is printed indelibly on the minds of all people in this state—notably the Davis County floods of 1923 and 1933. For each national forest permittee in the West, there are some 2,000 people dependent on the water that comes from the forest lands, not to mention several hundred hunters and fishermen enjoying the land recreationally.

Following the lead of the Utah Cattlemen's Association, the Utah Wool Growers' Association challenged the Salt Lake Tribune for its editorials defending the Forest Service. Under the title of "Watershed stability is still the main issue," the paper stated:

> "The Tribune makes no apology for its stand on conservation of natural resources. It has maintained and will continue to maintain that the primary consideration is the health and stability of the watersheds upon which hundreds of persons on farms and in towns and cities depend. We insist that the welfare of the greatest number takes precedence over the interests of the few, and we rely more on the studied conclusions of trained professional experts than on the opinions of interested users of public lands."

The same thing is now happening in Utah that happened in Minnesota. The attacks on government agencies, starry-eyed idealists and the "daffodil wing" of the conservationists, accusations of influence by big business and the effete East are coming again from a small, highly vocal and extremely selfish minority, a minority able, however, because of the primitive and basic frontier appeal of the issue, to swing larger groups to its way of thinking. Such minorities are usually a mere handful of the groups they claim to represent, and while larger groups may seem to be influenced by their outraged cries of anguish, invariably their good judgment and understanding prevails in the end.

The cattlemen of the West should not be judged by this particular group, any more than the vast minority of resort owners in Minnesota should be judged by a few operators who want to benefit personally from the monopolistic use of a natural resource that belongs to all.

The backlog of broad public sentiment in support of protective regulations is always composed of those who see the larger issues involved. Disinterest and unselfish attitudes increase in direct proportion to the number of miles distant that people live from a controversial area. This seems to be a national characteristic, held over from pioneer days, when a man protected his land from all comers, and what he did was his own business.

Federal lands are used for a variety of purposes—watershed protection, timber production, minerals, grazing, occupancy for tourist uses and facilities, homes, recreation, scenery, hunting and fishing. Under a multiple-use plan of management, all of these uses are important, and no single use should destroy any other. In evaluating such issues as the reduction of grazing allotments in order to save the range, what is actually at stake is not only this particular use, but all the uses inherent in the area involved.

Out of the 167 million acres in national forests, 62 million, or slightly less than one-third, are used for grazing purposes. Last year there were over 50 million visits to national parks and almost that many to national forests, a development which may, within the next two decades, reach to well over 200 or 300 million.

It is impossible to measure the value of forests in terms of watersheds, and judging by the growing importance of water in our economy today, there is no doubt but that this is one of the most important uses of public lands. In the eleven western states it has been estimated that as much as 53 per cent of the total run-off in streams originates within these forests. They are the main source of water supply for some 1,800 towns and cities, and some 600 hydroelectric plants.

As to mining, only 15 per cent of all mining claims have gone into patent, and only a small fraction of these are actually producing; 100,000 gas and oil leases have only produced 4,000 developed properties. On the other hand, timber production since 1941 has trebled and is still growing. In 1957, the income from timber sales on national forests amounted to $116,097,724. Recreation use has doubled, travel trebled and the value of water gone beyond price.

All of these uses are of great importance, and the miracle is that the lands have been so well managed under a multiple-use concept that to date there have been relatively few instances of one use destroying another. Present trends will surely continue at an accelerated rate. Conflicts and competition will also grow over the definition of multiple and dominant use, and we have not seen the end of pressure groups determined to destroy all concepts of sound management for private gain.

The surprising thing about federal lands is that the returns from various uses generally meet the cost of administration. This is one of the rare governmental responsibilities that pays for itself. This increase in revenue has been even more startling than the increase in their use. Revenues have increased, according to Clawson and Held, from $20-30 million annually, during the war to $300-350 million, at present a more than ten-fold increase in ten years.

Almost overnight federal lands have become big business. Expenses that during the war were from $40-50 million, are now from $150 to $170 million annually. After 1955, expenses were actually less than income, due possibly to the returns from gas and oil leases. It cannot be said that these lands are too expensive to keep. They have already demonstrated that they pay their own way.

The basic philosophy behind federal ownership is that only the government can give continuity and stability to natural resource management on these remaining public lands. While it can persuade, cajole and try to educate private owners, it cannot interfere too seriously with their prerogatives as to the property they own. When we consider such benefits as watershed protection, production of wildlife, growing of timber, preservation and proper use of scenic resources, development and maintenance of recreational opportunities, management of soils and grasslands, storage of minerals for the future, we realize that only a federal government can afford to operate on such a long-term, non-profit basis, if the people as a whole are to be served.

Private owners cannot be too concerned about such intangible benefits as scenery or services in the broad public interest, although there are exceptions, notably a few of the larger timber operators working toward sustained-yield forestry. There are genuinely interested and informed people in industry who have caught the vision and are looking to the future. Such leaders can contribute much, and in their policies lie hope in keeping the balance when small operators with selfish motives, such as the grazing permittees, gypo loggers or airplane operators, object to sound management practices, and feel their personal interests must be served at the expense of the public. The realization by some of these large corporations that it is not only good public relations, but that they cannot continue into the future without protecting the resource base upon which they depend, is encouraging, not only to the government from the standpoint of cooperation, but to all concerned in conservation.

But the public lands have more to fear than violent minority groups who operate at the local level. Exactly ten years ago, Huston Thompson, former Assistant Attorney General of the United States, and former Chairman of the Federal Trade Commission, said at the Inter-American Conference on Renewable Resources at Denver:

> "From the days of the establishment and withdrawal of our forest reservations, it is probably correct to say that there has never been a session of Congress during which bills were not introduced by special interests which, if enacted into law, would interfere with the control of our forests for the benefit of the public. The same can be said of national parks and other reservations."

What he said then can be said with just as much conviction today. New bills are constantly being presented, inspired in many instances by noisy minorities, to open the gates of these last preserves for private exploitation. So long as any resources remain under public ownership and control, we can expect a repetition of measures which have one clear-cut purpose, to get into the public lands while there is still a chance. While great progress has been made in consolidating federal ownership of public lands and protecting them, the old pioneer attitude persists, as evidenced by attempted raids of private interests.

The Long Bill of the 85th Congress (S.2579), which will certainly be considered in this session, would authorize the appointment of land study commissions in each state to compile recommendations about federal and state lands for eventual disposal to private interests. Although it contains weak provisions to placate fish, wildlife and recreation interests, the bill is being labeled as a thinly camouflaged giveaway promotion of minority groups.

A new grazing bill, as a result of the flareup in Utah, is almost inevitable. Too wise to risk the defeat of another "Bill to Improve the Taylor Grazing Act" (HR.2698 of 1955), the stockmen may attempt to camouflage it in innocuous language, slip it in as a rider on some major piece of legislation, trusting that in the confusion at the end of the current session, there might be a chance of passage.

H. R. Resolution 214 (85th Congress) to investigate the ownership of real property of the United States Government; S.550 to provide for payments in lieu of taxes to the states with respect to certain real property acquired by the United States, and a rash of similar bills that are always appearing, may in themselves be perfectly valid, were it not for the feeling that hidden in them somewhere is language which questions the entire concept of federal ownership and control of public lands.

A restudy of federal air space reservations (S. J. Resolution 29, 85th Congress), while it may be sound and be worthwhile generally, might actually be couched in language that would undermine the victory over airplane use in the Quetico-Superior country. In that same region forces are constantly at work to eliminate Congressionally authorized funds for acquisition of private lands in the roadless areas of the Superior National Forest.

Another threat to conservation accomplishment is the possibility of a hearing on the newly announced protective regulations of the Department of Interior on oil and gas leasing. If this matures, it will mean the exploration of any loopholes that could conceivably weaken the regulations now in effect.

No one knows what measures may be introduced before Congress adjourns, but judging by experience of the past, there will be a parade of bills and resolutions that will necessitate the utmost vigilance on the part of those concerned in the protection of public lands.

It must be remembered that the purpose of all such legislation is to turn over to a single type of use, a national resource which fundamentally has several uses. To relinquish these last reserves to private control would be a tragic mistake regretted for generations to come. Public lands must remain as public lands because of their diversity of values, and because private ownership cannot manage them in such a way as to adequately provide these values.

There can be no oneness in their use if the people are to be served. As an example, wilderness perpetuates wildlife, protects watersheds, offers scientific, educational and recreational opportunities and at the same time grows timber. By their very nature, many of these last reserves of rugged and formerly inhospitable terrain have a certain fragility due to high gradients, critical slopes and thin soil that necessitates less concentrated use than more favored areas. They are now public lands because of this very character, and most of them, therefore, need careful management, not on a single-use basis which could swiftly destroy them, but for all the inherent values they possess.

In view of our swiftly expanding population, and an industrial complex keeping pace with new needs, as well as with a growing world market, the question is not whether we shall keep the public lands we now have, but how we can enlarge them to provide a sane balance between urban development and the out of doors. Unless we have courage and vision to meet growing recreational needs by providing greatly expanded opportunities, not only in the West but the rest of the country as well, we may lose what we Americans prize in our heritage above all else, a perspective born of space and freedom and a feeling of closeness to the wide horizons of the past.

Our public lands have demonstrated their worth, and today are pouring more revenues into the national treasury than a negligent Congress actually appropriates for their needs. The agencies entrusted with their care cannot protect them or provide the services expected unless more adequate funds are provided.

They must be regarded as a reserve against the future, as an investment trust which should be drawn upon sparingly, and only for those purposes that give stability to our economy. No individual can feel secure without a backlog of resources, both material and spiritual. No nation can feel secure without similar resources. Our public lands provide both. We cannot afford to lose them or relinquish in the slightest any of the regulations for their protection.

Because of the enormous benefits these areas provide, benefits which because of their very nature private ownership cannot afford to consider, there cannot be any question as to the wisdom of maintaining public control. Rather than consider reducing their acreage or changing the type of management, wise judgment would indicate, in view of the need for more watershed protection and, above all, recreational opportunities, that the system be greatly enlarged to meet the demands of the future.

This may be the last opportunity. Ten years from now at the present rate of urban and industrial expansion, it may be too late. The problem before us now is to move while there is still time.

PART II

TECHNICAL SESSIONS

TECHNICAL SESSIONS

Monday Afternoon—March 3

Chairman: A. B. Cowan
Assistant Professor, School of Natural Resources, University of Michigan, Ann Arbor, Michigan

Discussion Leader: Walter Dykstra
Research Staff Specialist, U. S. Fish and Wildlife Service, Washington, D. C.

DISEASE, NUTRITION, AND CONTROLS

REMARKS OF THE CHAIRMAN

A. B. Cowan

It gives me great pleasure to welcome you to this session. The theme of this Conference is "Conservation in an Expanding Economy." In order to be sure that I understood the simplest meaning of the term "Expanding Economy," I asked our resource economist in the School of Natural Resources what it meant. He told me that it meant that either our standard of living was improving while the population either remained static or increased, or the standard of living remained constant while the population increased. In any event, it implies that there is increasing national production, and it is also very often associated with increased leisure time.

All this points to the strong possibility that in the not too distant future we will be expected to produce more and more game on smaller and smaller areas of land and water.

This brings us to the role of disease and nutrition investigators. These are not people who think and work outside the field of wildlife management. Rather, they are a small but growing group who are working in the field of intensive management. The importance of their role received recognition from the Wildlife Management Institute in 1950 at San Francisco, when the North American Wildlife Conference provided for the first of these technical sessions.

Unfortunately, the same recognition has not been forthcoming from the offices and the people who could provide the necessary opportunity in the form of time and money for the research which is so badly needed. However, the picture is changing for the better, though it is a slow change.

Most of what we now know about wildlife diseases has come from research in the fields of Public Health, Veterinary Science and fundamental Zoology. The welfare of the wild hosts has been secondary in interest, with major emphasis being placed upon their role as reservoirs of diseases and parasites which are important to man and his domestic animals or upon the disease-producing organisms themselives.

We must change this emphasis to one which makes the welfare of the wildlife our major concern. Just because nearly every wild animal we examine is parasitized, it does not mean that parasitism has no adverse effects. The Department of Agriculture spends millions of dollars annually to study parasites and diseases of livestock and poultry. If the problem is so great in the production of animals which live in practically ideal environments, think of the tremendous impact it must have upon animals which live under constant environmental stress. It is time that we ceased our complacent acceptance of regular losses of anywhere up to 60 per cent of our annual production of valuable wild species.

We who are interested in disease and nutrition believe that if we are given the opportunity to do the necessary research to learn the fundamentals of the disease processes operating in our wild populations, we can come up with management recommendations which will result in reduced losses and healthier populations of wildlife.

A PROGRESS REPORT FROM THE SOUTHEASTERN COOPERATIVE DEER DISEASE STUDY[1]

FRANK A. HAYES,[2] WILLIAM E. GREER,[3] EMMETT B. SHOTTS[4]
University of Georgia, Athens, Georgia

Unexplained mortality among deer (*Odocoileus virginianus*) of the southeastern United States has periodically perplexed sportsmen, game biologists and veterinarians. State and Federal files show that since 1890 approximately fifty major die-offs have occurred, with numerous minor enzootics having plagued deer throughout the southeastern region (Foote, 1955, and Greer *et al.*, 1957). In 1949 exceptionally heavy losses were encountered and in one area an estimated 90 per cent of the entire deer population succumbed from a disease of unknown origin (Holland, 1957).

In response to the epizootics of 1949 the U. S. Forest Service and representatives of the Southeastern Association of Game and Fish Commissioners suggested a cooperative arrangement to cope with similar situations which might occur in the future. Although no single state could justify a full-time deer disease diagnostic and research service, a regional organization seemed feasible. Following the months of September and October of 1955, during which abnormally large numbers of dead deer were found, a Deer Disease Sub-committee of the Forest Game Research Committee of the Southeastern Section of the Wildlife Society was formed (Foote, 1955). The objectives of this committee were (1) to summarize the history of past deer die-offs and past efforts to determine the causative agents; (2) to suggest a fact-finding program which could be coordinated with similar work outside the Southeast. From this subcommittee's findings and through the efforts of many state agencies and individuals, a joint-state deer disease diagnostic service was formed (Greer, *et al.*). The organization was designated as the Southeastern Cooperative Deer Disease Study, and it was officially inaugurated on July 1, 1957. At this time there were ten participating states, which included Alabama, Arkansas, Georgia, Florida, Louisiana, Mississippi, Maryland, Virginia, Tennessee and South Carolina. In November of the same year Kentucky became a member of the regional organization.

For this study adequate laboratory facilities and pasturelands for

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[1]This organization is supported through the joint efforts of the Southeastern Association of Game and Fish Commissioners, The U. S. Fish and Wildlife Service (P-R Act) and The University of Georgia.

[2]Assistant Professor and Project Director, Cooperative Deer Disease Study, Department of Pathology and Parasitology, School of Veterinary Medicine.
[3]Research Associate and Field Veterinarian, Ibid.
[4]Research Assistant and Medical Laboratory Technologist, Ibid.

experimental animals have been made available at the University of Georgia. From the central station a fully equipped field unit is on a 24-hour stand by and can be dispatched within a few hours. A veterinarian and technical associate comprise the field-team and those investigators are prepared to work in a given area for whatever length of time is necessary to obtain sufficient information and materials for arriving at a diagnosis. Should simultaneous die-offs occur in different areas, three field-diagnostic units are available for travel.

Regardless of initial impressions of what might be an obvious etiological factor, all investigations are conducted with a maximum of consideration for nutrition, parasitology, toxicology, virology, bacteriology and mycology. Every effort is made to avoid a future necessity for "making assumptions" pertaining to causative agent(s) of the disease condition. All tissue and specimens are preserved and returned for processing at the central laboratory. Complete histopathological studies are made according to the gross lesions observed at necropsy. All parasites acquired at post mortem are identified (genus and species) and counted. Where it is indicated, transmission studies are made using chick embryos, rabbits, guinea pigs, chinchillas, goats and deer as experimental subjects.

In a study of this kind it is understood that extended periods of time might lapse between "field-calls" involving deer diseases. In order for a diagnostic laboratory to maintain maximum efficiency, however, it is essential that the personnel be continuously engaged in diagnostic work. This is accomplished through routine practice procedures with domestic animals which are processed through the school's post mortem and clinical pathology laboratories. Newer methods for collecting materials and preserving specimens are being sought and more advanced diagnostic techniques are being investigated.

Concurrent with the above studies, the personnel of the Cooperative Deer Disease Study is in the process of conducting a complete literature review on diseases which have been reported to affect deer. These accounts are being systematically filed and indexed according to the punched-card method described by Levine (1955). This information is invaluable as future reference material.

In addition to the joint-state diagnostic service afforded by the project, fundamental and applied research projects are being conducted. To date these include:

1. An intestinal parasite survey of wild deer in the Southeast;
2. An anatomical and histological study of wild deer in the Southeast;

3. Preliminary studies on the incidence of leptospirosis and brucellosis among wild deer of the Southeast;
4. An investigation to determine means for improvement of methods for preservation of field collected blood specimens;
5. Studies to determine the normal hematology of the southeastern deer;
6. Blood chemistry analysis of the southeastern deer.

Arrangements are being made for further expansion on the basic research phase of the study, and within the immediate future several additional projects are anticipated. Some of these will be in conjunction with similar or associated studies which are being conducted at the University.

Since the formation of the Cooperative Deer Disease Study (July 1, 1957) the diagnostic services rendered are briefly discussed in the following itemized form.

1. *Arsenic Poisoning in a Louisiana Deer Herd.*—This die-off occurred in a three-parish area on the eastern Mississippi levee region (Concordia, Tensas and Madison parishes) during the months of July and August of 1957. The overpopulation of this particular herd necessitated the browsing of poisoned cotton plants in the area and subsequently caused the intake of toxic amounts of insecticidal arsenic compounds.

2. *Malnutrition and Starvation in the Everglades Deer Herd.*—The prolonged high water in the "Sawgrass" area of southeast Florida resulted in a decrease of the natural food supply for the deer. This occurred during the latter part of September and extended through October of 1957. The ecological alteration within the region was due to the drainage water from Lake Okeechobee. A limited parasite survey was conducted on the deer examined and showed that three of the five deer sacrificed were free of intestinal helminths. The two parasitized animals showed a very slight infection with lungworms (*Dictyocoilus* sp. and *Prostrongylus* sp.) and moderate stomach worm infection (*Haemonchus contortus*).

3. *Evidence of* Laminitis *in Two Mississippi Deer.*—Examination of hoof specimens from two male deer killed on the "Leaf River Area" of Mississippi showed evidence of hoof wall separation from the sensitive lamina. The exact etiology of the condition is not known, although it is a relatively common occurrence in horses and less frequent in cattle. A dietary or digestive disturbance is usually involved causing a venous congestion (histamine type action). Due to the very limited space of the laminar vascular bed, stagnation of blood occurs in the

feet. A degenerative process ensues, thereby producing a deformity in growth of the hoof wall.

In retrospect of this presentation and previous historical accounts, during the late summer and fall of 1957 nature apparently was extremely "kind" to many deer herds of the Southeast. In the past it has been during this time of year that the most serious disease outbreaks occurred. These die-offs seemed to appear at 5- to 10-year intervals; therefore, many areas in the Southeast are statistically overdue. During this "period of grace," all available time has been used for forming a smooth functioning and efficient organization. It is hoped that wildlife conservation and all related aspects of the study will eventually benefit from these efforts.

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DISCUSSION

DISCUSSION LEADER DYKSTRA: I think you all appreciate that the work Dr. Hayes and his group in the Southeast have been doing represents the sort of cooperative pooling of resources that can produce tremendous benefit to game administrators in all parts of the country. Certainly this field of wildlife diseases is so complex and technical that individual states do not have the facilities or manpower to find answers to all of the questions that may be presented.

MR. WILFORD OLSON [Colorado State University]: Your finding of parasites in these animals doesn't correspond with my experience with deer in the South. Were your field examinations conducted in such a way that you would be sure to find the very small species that exist in the intestines, stomach, and kidney?

DR. HAYES: In this particular work in the Everglades they were. Dr. Greer, who is our field investigator, conducted the survey and we were extremely conscious of those things that you mentioned. Some of our work in the past has been done with fixed material. This particular survey surprised us in that three of the five deer were absolutely free of parasitism, especially since the deer had been crowded into small islands with a minimum food supply.

MR. OLSON: Can you give us more on whether or not parasites from deer affect livestock?

DR. HAYES: We have found that to occur throughout the South. However, it did not occur in the deer of the Everglades area, which also was surprising and in contrast to previous observations.

DR. DAVIS [Colorado]: In setting up the framework for this procedure, what was the initial amount of money involved?

DR. HAYES: The present budget for 1957-1958 was $18,300, split on a pro-rata basis for each state.

PRELIMINARY OBSERVATIONS ON DISEASES IN THE 1957-58 OUTBREAK OF MICROTUS IN WESTERN UNITED STATES

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A natural phenomenon of unusual proportions is occurring at this time in several localities in northwestern United States. It is of special interest to many of us because of the location in easily accessible fertile agricultural areas and not in Ungava, Labrador, Point Barrow, or distant Siberia. I refer to the population irruption of the meadow vole, *Microtus montanus,* in parts of four western states.

The history of population fluctuations and cycles in rodents and other small mammals throughout the world is well presented by Elton (1942) in his book, *Voles, Mice, and Lemming,* but it is impractical even to abstract this vast amount of information here.

Only two fairly well documented spectacular outbreaks of mice or voles are reported for western United States, although others of significant proportions must have occurred. Vernon Bailey (1936) writes of an outbreak in Nevada as follows:

"In Nevada in 1907 these mice [*Microtus montanus montanus*] devoured practically all the alfalfa and most of the other crops and killed many of the fruit and shade trees in the lower Humboldt Valley, causing a loss to the ranchmen estimated at $250,000. In this case their numbers in some of the alfalfa fields were estimated at several thousand to an acre, far more than a heavy crop of alfalfa could support for any considerable length of time. Such conditions are possible anywhere under circumstances favorable to the rapid increase and complete protection of the mice from their natural enemies." This overpopulation extended into two growing seasons.

The Kern County, California, outbreak is described by Wayson (1927) as follows:

"During the latter part of 1926 and the early months of 1927, the migration of large numbers of the native meadow mouse (*Microtus californicus estuarinus*) and of the house mouse (*Mus musculus*) from a land basin in Kern County, California, to outlying agricultural dis-

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tricts, caused much annoyance and considerable economic loss to the farmers of the communities affected.

"Studies of the migrations were made by F. E. Garlough and W. P. Taylor, representatives of the United States Biological Survey. During their investigations of the causes and origin of the infestation, and of the application of suitable control measures, they observed many sick mice of each of the two species. The sick animals sat about with roached backs, roughened pelage, labored breathing, and with their eyelids glued together with purulent exudate, and were easily caught by hand. Carcasses which were partially destroyed, apparently by the cannibalistic feeding of the hordes of live mice, were also found."

DISEASE STUDIES

The disease history associated with mouse outbreaks in North America has not been well documented. However, even the 1906-1907 episode in Nevada received some epidemiologic considerations for Piper (1908) reported "at intervals from January to March dead and dying voles were noticed in locations where poisoning could not have been the cause but efforts to prove this mortality due to some specific bacterial disease failed." Tularemia, not recognized as a disease at this time, may have been the cause of some mortality.

In the 1926 and 1927 outbreak of voles, *Microtus californicus estuarinus,* and house mice, *Mus musculus,* that occurred in Kern County, California, the population numbers and damage appear to have been aggravated in certain localities by a definite migration of the animals. Many sick and dead animals were found.

Dead mice were sent to the U. S. Public Health Service laboratory at San Francisco. Wayson (1927) reported that 24 of 42 voles and 6 of 12 house mice examined presented a rather characteristic gross pathologic picture. He also reported the isolation of "*Bacillus murisepticus*" (= *Erysipelothrix muriseptica*), the organism of mouse septicemia. No other pathogen was identified.

Another epizootic occurred among meadow mice, *M. californicus estuarinus,* in Contra Costa County, California, in 1927. Mice were very abundant, at least in restricted areas, and many sick and dead ones were observed. Two dead mice from this area were examined by Dr. Perry of the Public Health Service, who reported (1928) the isolation of *Pasteurella tularensis* from them. This appears to be the first report of isolation of *P. tularensis* from meadow mice in nature.

There are no records of human illness associated with either of the outbreaks in California.

The common muskrat, *Ondatra zibethica,* is a microtine rodent and closely related to the voles. The population of this species fluctuates considerably. Tularemia has been identified in widespread epizootics in muskrats, and they have been the source of many human infections. With this animal there is intimate human contact during trapping and skinning. Parker, Steinhaus, Kohls, and Jellison (1951) reported over 100 human cases of tularemia in North America from handling infected muskrats and beavers.

As both muskrats and beaver are often taken in the same day's trapping and both are reservoirs of tularemia, it was often impossible to establish which animal was the actual source of infection. In epizootics of tularemia among semi-aquatic mammals, voles in the adjacent meadows are often infected as well as the muskrats and beaver. The above report included 8 cases of tularemia among trappers, February and March 1950, at Utah Lake, Utah, where a muskrat epizootic was in progress. It also included 8 cases among muskrat trappers in 1942 near Klamath Lake, Oregon, where tularemia was epizootic in muskrats and apparently also in voles. One of the tularemia victims at Chiloquin, Oregon (O. S. Keysor, 1945) wrote "The winter and spring that the muskrats died in such large numbers the field mice died by the millions too. Also the tulie mice [= *Microtus*] and for more than a year we saw neither field mice or tulie mice. They have come back this year in large numbers as have also the muskrats."

Findlay and Middleton (1934) described a pathogenic protozoan which they considered to be the main cause of mortality among voles in England during a period of abundance and high mortality. They named this organism, which forms lobulated cysts in the brain of *Microtus, Toxoplasma microti*. It was found in 19 of 63 voles that died soon after capture. However, many of them were too decomposed for examination so the infection rate may have been higher.

They claimed successful transmission of the organism to healthy voles with production of typical brain cysts and death. Nervous symptoms were described in experimentally infected voles. No other infectious agent was encountered and they concluded that "the only apparent cause of death has been the presence of cysts of a toxoplasm in the brains of the voles."

Frenkel (1953 and 1956) discussed the parasite described by Findlay and Middleton. He expressed the opinion that it is not a true *Toxoplasma*. He also described a similar organism which he found in voles, *Microtus modestus*, in Montana. He was unable to transmit the Montana vole organism by experimental means. The Montana vole organism was designated merely as the "M" (for *Microtus*) organism.

Khatenever (1943) outlines five main epidemic types of tularemia observed in the U.S.S.R., where rodents appear to be most important as sources of human infection, in contrast to North America, where rabbits are the chief source of infection. Khatenever's epidemic types are: (a) Trade outbreaks resulting from hunting, skinning, and preparing hides and carcasses of rabbits, water rats, and other wild game or fur-bearing animals; (b) agricultural outbreaks from more or less direct contact with mice by farmers during epizootics; (c) contact outbreaks from food contaminated by infected mice; (d) water outbreaks from direct contact with or ingestion of contaminated water, but not including cases from contact with water animals; and (e) tularemia transmitted by arthropods (ticks and insects). All of these epidemic types involve mice directly or indirectly.

Khatenever further states [translation]: "The basic origin of the mass of tularemia infection among persons in the territory of our union appears however to be the water rat, then secondarily, infections of field mouse origin."

The water rat referred to above is a microtine rodent, *Arvicola terrestris* (= "*Arvicola amphibius*") which is an unusually large vole with habits much like those of our muskrats, *Ondatra* spp., and which is hunted and trapped by the millions for furs. In one epidemic of tularemia in water-rat hunters, Khatenever recorded 274 cases of tularemia in 310 hunters, an infection rate of 88.4 per cent. In the above quotation, Khatenever's reference to field mice probably refers to various small microtine and murine rodents but prominent among them is *Microtus arvalis,* the gray field mouse.

In the U.S.S.R., the well organized and concentrated efforts of research workers in ecology, which are described by Elton (1942) have at least produced a vast amount of literature on rodent populations, rodent diseases, and rodent parasites. I do not know whether or not they are able to control population irruptions, but I would estimate they are about four Sputniks ahead of us in this field of biological research.

THE PRESENT DISEASE STUDY

None of us involved in the present study observed either of the North American outbreaks referred to previously or anything else comparable to the present invasion in the Northwest.

Our interest is in diseases that are present in such a peak population and those that may be involved in the population decline which is expected to occur. Up to the present time, no intensive study of diseases in such a mouse population has been made in North America.

The history of the present outbreak is brief. There was very little evidence of unusual mouse numbers in 1956 in the area involved. Calls for poison bait for mice were about the same as in previous years. In the spring of 1957, excessive numbers were noted in several places and by mid-summer, damage was reported. When late cuttings of alfalfa hay, alfalfa seed, clover seed, and grain were harvested, serious rodent damage became obvious. Potato crops suffered and growers reported 5 per cent to 30 per cent loss from defacing of tubers by mice. Agricultural agents in Klamath County, Oregon, alone have estimated a crop loss of 2½ to 3 million dollars. The estimate for the State of Oregon is about 5 million dollars.

These voles do not hibernate and as winter progresses, their depredations continue even though concealed by a covering of snow. Crowns and roots of both clover and alfalfa are being eaten. Irrigation ditch banks are already riddled with burrows. Grass meadows are honey-combed with burrows and runways, but the damage here may not be serious because grass sod quickly regenerates. Away from cultivated areas, wild shrubs are being girdled and even the upper branches debarked on occasional plants. In the fruit-growing areas of central Oregon and the Snake River Valley in western Idaho, there is more concern about damage to fruit trees by girdling. It takes only a few mice to do a great amount of damage in this way. Fruit is not an important crop in the Klamath Basin where our studies have been concentrated.

Some of us have visited the Klamath Basin on three occasions, November 7-16; December 2-10; December 27 to January 11. On the first trip, 100 mice were autopsied in the field including 22 found dead and 78 captured or trapped. One hundred twenty-six mice were brought to the Hamilton laboratory alive and held for observation for various periods.

On the second trip, 178 mice were autopsied, including 57 found dead and 121 captured or trapped. One hundred fifty-five were brought to Hamilton alive. On the third trip, 355 mice were autopsied, including 139 found dead and 216 captured or trapped. About 40 were brought to the laboratory alive.

The first isolation of *P. tularensis* was made from a vole which died November 17 within 12 hours after arrival at the Hamilton laboratory. The animal exhibited a small caseous node in the left axilla and an enlarged spleen. Twenty-three other isolations were made from animals brought back alive, but 20-30 animals had been confined per cage for the trip. Since some cannibalism was noted, this may represent only one or two valid field infections. At least 6 mice exhibited gross lesions of small to large abscesses in the body cavity, the spleen, liver, or enlarged purulent peripheral lymph nodes. These were not infected with tularemia but were thought to have nonspecific infections and will be discussed later.

Materials collected on the second trip, including two pools of tissue, yielded 49 isolations of *P. tularensis.* On this trip we encountered at least one epizootic area of tularemia. A rancher in Poe Valley, Klamath County, Oregon, reported excessive numbers of dead mice in his fields. A visit was made to the area on December 8. In one field of grain stubble, the baled straw had not been picked up. Turning of 16 bales uncovered 25 dead mice, many of which were fresh and in excellent condition for autopsy and showed lesions suggestive of tularemia. Parts of dead carcasses were also found under the bales. Some dead mice were found curled up in their nests. The manager of this farm assured us that poison had not been distributed in the field. Twenty of these dead mice yielded 14 isolates of *P. tularensis.*

One or more animals dead of tularemia were found on each of 12 farms in the vicinity of Klamath Falls.

On December 23, six samples of water were received from various points in Poe Valley. *P. tularensis* was isolated from four of these, including a sample from a ditch in the epizootic area and a sample from Lost River where it leaves Poe Valley.

On the third trip, December 27 to January 11, tularemia was found in epizootic proportions in two other areas. These were an abandoned farm yard about 20 miles south of Klamath Falls, Klamath County, Oregon, and an alfalfa field, with many bales in it, about 20 miles south of Tulelake, Siskiyou County, California. A few infected voles were found in other locations and the Poe Valley area was again the source of many infected mice. A total of 80 isolations of *P. tularensis* were made from 355 voles collected.

In January, *P. tularensis* was isolated from water samples collected in the following areas: Wood River near its source; several small streams near Fort Klamath; Lost River in Poe Valley; and several drainage ditches near Tulelake, California.

On the second and third trips, live voles were observed that appeared to be crippled or sick. When captured these were found to have greatly swollen feet. This condition we have designated as "big foot." The disease is transmissible by inoculation. Cultures yielded a streptococcus and the disease has been reproduced with cultures in white mice, voles, and wild-caught deer mice, *Peromyscus maniculatus.* In Oregon, natural infection has been found in the vole, *Microtus montanus;* the deer mouse, *Peromyscus maniculatus;* the harvest mouse, *Reithrodontomys megalotis;* and the house mouse, *Mus musculus.*

The streptococcus involved appears to be responsible for many infections manifested by enlarged nodes and large abscesses found in other voles and referred to earlier. Although the infection shows some predilection for the feet, it can cause extensive lesions elsewhere in the body. A total of 75 voles and mice so affected has been examined. This streptococcus has some peculiar features that are being studied and we are inclined to think it is a distinctive infectious agent. The mode of transmission in nature has not been established. We are not aware of any previous published reports of such a disease in voles. A somewhat comparable infection in the feet and tails of mice caused by *Mycobacterium ulcerans* is decribed by Feldman, Karlson, and Herrick (1957).

Pasteurella pestis infection has not been detected but would scarcely be expected since winter is not favorable for the spread of sylvatic plague. Sylvatic or campestral plague has been found in many counties in Oregon in past years. A vole, *Lagurus curtatus*, is an important reservoir of plague in Washington, and infected *Microtus californicus* are frequently found in the San Francisco area so it is reasonable to expect that plague will be found in the study area if the high population extends into the summer months. The only other specific infectious organism that has been identified is the pulmonary fungus, *Haplosporangium parvum,* which has a wide host and geographic range in western United States and Canada. It is a very mild pathogen and was found in only one vole. These voles are consistently infested with lice, *Hoplopleura acanthopus* and mites of the genus *Laelaps*. Three distinct types of cestode cysts have been found in internal organs of voles. House mice, *M. musculus,* are in close association with voles in haystacks and two of three examined were infected with *Spirillum minus,* the agent of rat-bite fever.

IMPLICATIONS

The present vole outbreak in the West has many serious economic and biologic implications in addition to the damage that has already been done. It is expected that many alfalfa and clover fields will be ruined before spring and will have to be plowed. This will seriously disrupt established crop rotation schedules. If the present population persists it may be impossible to raise crops in many fields next season. Mice have eaten up much of the grain and other food ordinarily used by upland game birds in winter and by migrating waterfowl in fall.

Control programs planned for early spring will require distribution of tons of poisoned grain. Upland game birds and waterfowl will be pressed for food at this time. To what extent poisoning will affect hawks, owls, crows, and gulls that feed on live and dead mice is problematical. Some poisoned birds have been found in the area already. Wild mammalian predators are already extremely scarce in the area concerned because of very successful predator control.

The State of Oregon has appropriated $100,000 for mouse control and $10,000 for research for 1958. This is only a small part of the cost of the proposed control program.

SUMMARY

Excessive numbers of small rodents which are of interest in wildlife research are usually reported in foreign lands or distant subarctic regions. Right now a spectacular population irruption of voles, *Microtus montanus,* is in progress in parts of 4 western states. It is occurring in fertile agricultural areas which are conveniently accessible from cities and research laboratories. The techniques and professional staff are now available to study these voles, their parasites and diseases, and the ultimate decline or crash of the population.

Our own studies of diseases have been productive. Over 1100 voles and mice have been examined. Tularemia infection has been found in 132 voles, which is probably a greater number of laboratory-confirmed tularemia infections than has been found in any epizootic study in North America. *Pasteurella tularensis* was also isolated from 14 of 37 water samples tested. A streptococcus infection, not previously recognized, was found in 75 voles and mice. One manifestation of this infection we have designated as "big foot" disease. *Haplosporangium parvum,* a pulmonary fungus, was found in one vole. Rat-bite fever was found in house mice in the area in close association with voles.

We believe this population irruption still offers an unexcelled opportunity for study and we would like to encourage the participation and cooperation of others.

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DISCUSSION

DISCUSSION LEADER DYKSTRA: We are indebted to Dr. Jellison for his timely report on the current irruption of mice on the West Coast. It is something that certainly doesn't happen every year. In fact, we have rather detailed accounts of two previous irruptions that were in rather extensive scales; one in California and, before that, one in Nevada.

MR. WELCH [Fish and Wildlife Service, Denver]: As you know, we have had two of our laboratories in the Northwest attempting to find a more effective poison to control these animals. I note the high incidence of tularemia. Do you feel that this would contribute to the dying off of this mouse population?

MR. JELLISON: We think it will contribute, but we do not know to what extent. We have found it in epidemic proportions on at least three occasions. However, while it may be quite a factor, we cannot feel that it is general.

MR. HENSLEY [Michigan]: Do you have any data concerning rodent-eating snakes during these outbreaks?

MR. JELLISON: Our first trip there was in November and by that time all reptiles were in hibernation.

DISCUSSION LEADER DYKSTRA: One question that has bothered a number of us who have followed this situation is why these irruptions take place. Do you want to comment on the ecological conditions that appear to be factors in the irruption of this past year?

DR. JELLISON: We don't know why these outbursts occur at certain times. It has been well established that there are cycles of abundance every four years and then a period of scarcity. On two previous instances mice appeared in enormous numbers in the West. One was in Nevada in 1906 and the other in California in 1927. Animal students have tried to explain this on the basis of sun spot cycles, hormonal cycles and one thing or another. I don't think there is a good explanation. We feel that in this instance we are going to learn what kills them. We will follow this population through until it disappears and then we may know what happens when they die. However, as to your particular question, I cannot answer it.

WILDLIFE-DAMAGE CONTROL PROBLEMS ON PACIFIC NORTHWEST TREE FARMS

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As forest lands are placed under intensive management to insure a sustained yield of forest products, factors which prevent or delay the prompt regeneration of future forest crops cannot be tolerated. Formerly, fire was the single most destructive agent. However, intensive fire suppression programs have greatly reduced this hazard so that now the total annual losses due to biological agents (diseases, insects, and animal damage) exceed that of fire. The impact of animal damage to commercial forests in the West during 1952 totaled 101 million cubic feet of growing stock (U. S. Forest Service, 1955). Animal damage is of primary importance because it results in unsatisfactory regeneration of cutover lands and suppressed growth of young seedlings. In the Pacific Northwest, a number of animals—deer, elk, bear, mice (*Peromyscus*), shrews (*Sorex*), hares, and mountain beaver (*Aplodontia*)—are responsible for delaying and interfering with the development of second-growth Douglas-fir stands. The serious nature of the wildlife damage problem facing foresters in this region has been recognized for some time (Moore, 1940). Economic losses from wildlife damage to seed, natural seedlings, plantations, advanced reproduction, and sapling timber are estimated to total $875,000 annually in the timber on Weyerhaeuser Timber Company tree farms in the Douglas-Fir Region. The losses on which the total estimate is based are summarized in Table 1.

In forestry terms, wildlife damage to seed and seedlings prolongs the establishment period of a stand and lengthens the rotation. Destruction of seedlings and advanced reproduction may thin stands too early and lead to understocking and poor form of the final crop trees.

TABLE 1. DISTRIBUTION OF ANNUAL LOSS TO DOUGLAS-FIR GROWING STOCK ON TREE FARMS OF WEYERHAEUSER TIMBER COMPANY.[1]

Class of growing stock	Average annual loss	Nature of damage
Plantations	$175,000	Rodents and big game—effective growth reduced approximately 50 percent.
Stand establishment period 0-20 years	$600,000	Loss of seed and seedlings to rodents; loss of young reproduction to big game.
Sapling and poles	$100,000	Bear damage—covers approximately 50,000 acres.

[1]Based on estimates developed in June 1957 from stocking surveys of cutover lands, appraisals of damage to plantations, reseeding and replanting costs, aerial surveys of timber stands, and from detailed records of wildlife damage to research plots.

In effect these annual losses represent a continuing attrition of the sustained yield capacity of the land. To accomplish the tree farm objective of providing a continuing supply of forest products it is necessary to control wildlife damage during the critical period of re-establishment and initial growth of the newly developing forest stands.

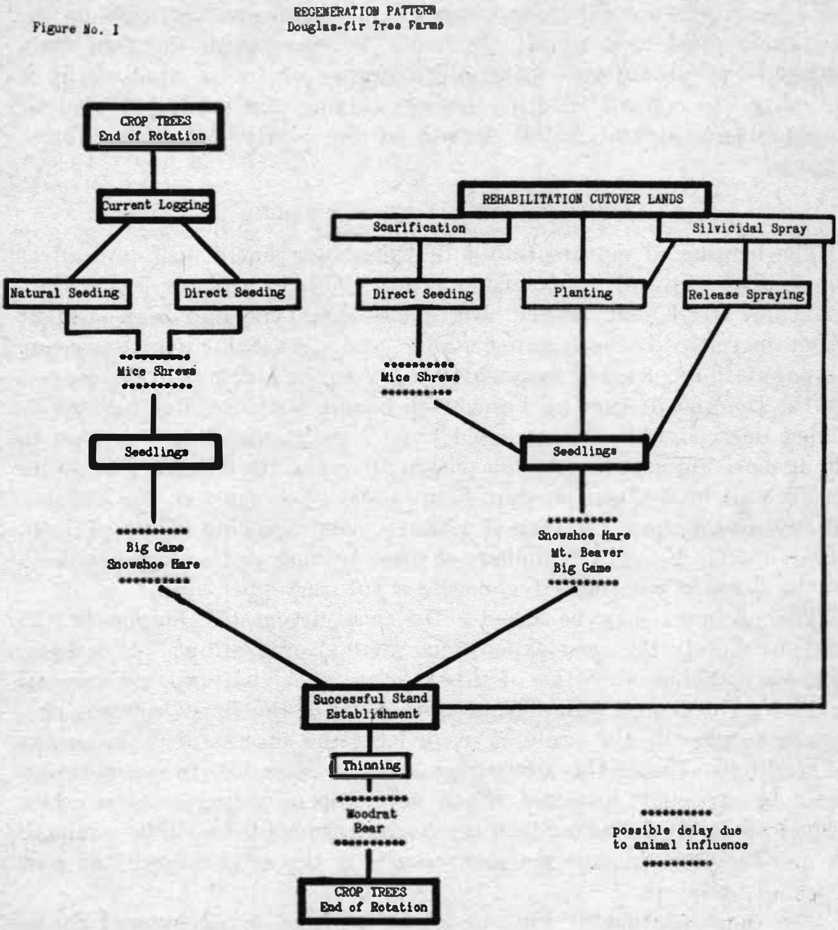
ORIGIN OF THE DAMAGE PROBLEM

The logging of mature stands of Douglas-fir has a profound effect on wildlife (Cowan, 1956; Baker *et al.,* 1955; Lauckhart, 1955; Garman and Orr-Ewing, 1949). Big game—deer, elk, and bear—benefit from the removal of old growth stands, and spectacular increases occur in populations of small mammals—mice, hares, and mountain beaver. In the Douglas-fir type on Vancouver Island, British Columbia, black-tailed deer populations increased from 1 or 2 animals per section to 20 or more animals per section within 10 years after logging (Cowan, 1955) and in western Oregon, 5- to 10-fold increases in the number of *Peromyscus* have been noted within a year following logging (Gashwiler, 1955). Excessive numbers of these animals can become problems to the forester who must regenerate a future timber crop.

The question may be asked: "Is clearcutting of Douglas-fir the best, or merely the most expeditious method of logging?" It is both. The silvical characteristics of this tree are such that exposed mineral soil is the ideal seed bed. Complete removal of the forest cover is necessary to provide the sunlight needed for the successful development of seedlings. Under this silvicultural system some loss to regeneration must be expected; however, if the new crop of young trees is established promptly following logging the losses to wildlife will be minimal. A more serious damage problem results if the establishment of new stands is delayed.

The rehabilitation of idle, understocked and brush-covered forest land is a special problem. These problem lands are an inheritance from the days of progressive clearcutting with railroad logging. Natural regeneration that developed was frequently destroyed by uncontrolled fires. As fire suppression measures increased in effectiveness, denuded land quickly grew up to brush[2] making an ideal habitat for big game and other forms of wildlife. This general sequence of events is well known and has occurred in other forest regions of the United States following the logging of virgin forest (Bartlett, 1950; Leopold, 1950; Grange, 1949; Foote, 1945).

[2]Brush is used colloquially to mean a combination of shrubs and non-merchantable hardwoods such as vine maple, cherry, and bigleaf maple.



WILDLIFE DAMAGE CONTROL

To outline the operational aspects of specific control practices would merely duplicate published information that has been summarized by Eadie in his book, *Animal Control in Field, Farm, and Forest* (1954). This discussion will be concerned with the ecological inter-relationship between wildlife damage and the pattern of forest regeneration. An understanding of these relationships is necessary to the forester for intelligent planning of control programs. Figure 1 presents a schematic outline of the pattern of regeneration on Weyerhaeuser tree farms. The points in the stage of forest development where wildlife influence may interfere or delay the normal pattern of stand development are indicated by breaks in the flow chart. Animals associated with these delays are listed.

The problem of obtaining regeneration has two phases: (1) regeneration following current logging (a company-wide program) and (2) the rehabilitation of idle, understocked and brush-covered land which is no longer producing a timber crop. The latter is accomplished by means of mechanical scarification[3] and herbicidal sprays by which the forester modifies existing conditions to produce new conditions suitable to the establishment of Douglas-fir. In both phases, direct seeding is a key management practice.

Direct seeding of Douglas-fir was not practical (Garman and Orr-Ewing, 1944) until the development of a protective seed treatment (endrin-arasan coating)[4] to reduce the destruction of seed by mice and shrews (Kangur, 1954; Spencer, 1954). The use of treated seed is in effect a poison bait. Field tests show that by seeding at a rate of one pound per acre (an average of 40,000 seeds) satisfactory rodent control is achieved with sufficient seed left to provide a first-year stocking of about 2,000 Douglas-fir seedlings per acre (Dick, *et al.*, in press).

Recently, clipping of young seedlings in the cotyledon stage by mice (*Peromyscus*) has been recognized as a serious problem. Kverno and Hartwell (1957) report losses among recently germinated seedlings of 70 per cent or more. Our laboratory studies indicate that *Peromyscus* readily accept seedlings in the cotyledon stage as food. As soon as true needles develop, stem clipping stops as mice then confine their feeding to remaining cotyledons. Control of this damage is also considered to be a seed treatment problem: that of finding a systemic protectant for seed. The material would be used to impregnate the endosperm so that the chemical would be absorbed by the seedling upon germination. This approach to the problem is presently under investigation at the Forestry Research Center.

To use direct seeding for the establishment of Douglas-fir regeneration, proper seedbed conditions must be present. Both logging and scarification achieve this. However, the ecology of currently logged land and scarified land are vastly different as regards wildlife populations. In the first instance, destruction of the old-growth forest initiates plant succession that becomes increasingly more favorable for wildlife. On the scarified area, a relatively favorable environment is

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[3]The destruction of existing ground cover is accomplished by tractors with land-clearing blades.

[4] 0.5 per cent endrin, 2 per cent arasan-75 by weight plus Dow latex as an adhesive. Treated seeds are aluminized to deter birds. (Annon., 1956).

temporarily destroyed. The revegetation of scarified land is rapid and the elimination of dense brush cover usually improves the environment for wildlife. Both effects, logging and scarification, tend to increase wildlife pressures on Douglas-fir reproduction. However, there is a marked difference in the initial intensity of this pressure due to the relative number of animals present. By promptly securing regeneration following logging, young trees will be growing as the wildlife damage potential is building up. Thus, seedlings that become established during the first growing season following logging will be less subject to serious injury than seedlings that become established at some later date. In light of this reasoning, the company has discontinued a former policy of waiting five years for natural regeneration to develop. Currently logged areas are now seeded immediately. In contrast to this, seedlings that develop on scarified lands may be subject to wildlife pressure from the start. To reduce the severity of wildlife damage on rehabilitated lands will require intensive control measures. This is the major problem facing the forester on scarified lands as well as those areas where brush control has been achieved by use of herbicidal sprays.

Second-growth stands are not immune to wildlife damage. Both bears and woodrats can cause serious losses. Bear damage is characterized by the stripping of bark from the boles of conifers. Claw marks may be evident on the exposed sapwood. Injury occurs most frequently at the base of a tree but has been noted on the bole up to heights of 50 feet (Childs and Worthington, 1955). Woodrat damage resembles that of porcupines, where branches and main stem in the gnawed and frequently girdled resulting in poorly formed trees. Damage by these animals cannot be tolerated in second-growth stands.

CONCLUSIONS

The solution of forest wildlife damage problems presents a real challenge to forester and wildlife biologist alike. Research is continually seeking more effective means to control damage. An outstanding example of the progress in wildlife damage control is the development of an effective protective coating for coniferous seed. This recent achievement is proving of major significance in the advancement of forest regeneration practice. Treated seed permits the effective use of direct seeding as a means of establishing Douglas-fir forest. The development of a systemic wildlife repellent for seedlings would represent another major achievement. Systemic repellents are exemplified by a number of naturally occurring substances that are absorbed by various plants which alter the palatibility so that they are not readily accepted as food by certain animals. This approach has distinct possibilities in forestry to control clipping and browsing damage. Research on systemics is receiving high priority in our investigation program.

The real challenge in controlling wildlife damage in the forest is not in the field of chemical controls, but in gaining an understanding of ecological factors involved and in putting this knowledge into practice.

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DISCUSSION

DISCUSSION LEADER DYKSTRA: I am sure that you are all impressed with the progress that the timber people have made in applying the fundamentals of wildlife management to the type of problems that confront them. It is a case of not only manipulating the environment to make it more suitable for trees and less suitable for wildlife but of applying the knowledge that we are gaining of these new chemical compounds which have tremendous possibilities as systemic repellents and seed protectives.

MR. C. E. WILLIAMSON [Wyoming]: Is there much erosion hazard in your scarification practice to remove existing ground vegetation?

MR. LAWRENCE: No.

DISCUSSION LEADER DYKSTRA: I might just comment on the seed protective formulation. Its primary purpose is not to kill the mouse but to give him an amount of toxic material so that he gets a bellyache and becomes educated to the fact that these seeds are not good food. Of course, under field conditions, you cannot control the intake of an animal and so you do have some mortality. However, you do get a greater degree of protection than you do from rodenticides.

HOOKWORMS, *UNCINARIA LUCASI* STILES, 1901, IN FUR SEALS, *CALLORHINUS URSINUS* (LINN.), ON THE PRIBILOF ISLANDS[1]

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Hookworms are the only helminth parasites known to infect the pups of fur seals on the Pribilof Islands. They occur in a large percentage of the young animals, often in great numbers, and are considered an important factor in the high mortality of pups. The death rate has risen during the past 30 years from about 2 per cent to over 20 per cent.

The objective of this investigation was to study the biology and ecology of the hookworms for the purpose of developing a basis for controlling them, and thereby reduce seal mortality. This paper constitutes a report on these studies (Olsen, 1952, 1953, 1954, 1956, and Dixon, 1955).

REVIEW OF LITERATURE

The first significant published report of hookworms in fur seals appears to be that of Lucas (1899). From a few specimens collected by him, Stiles and Hassall (1899) recognized them as an undescribed species of *Uncinaria* too poorly preserved for critical study. They assumed the life cycle of these worms to be similar to that already known for hookworms occurring in man and dogs. Under the crowded condition on the seal rookeries, they believed that heavy infections

[1]This study was conducted during the summers of 1951-56 under the auspices of the U. S. Fish and Wildlife Service.

of hookworms would develop, resulting in uncinariasis similar to that in man and dogs where there is loss of blood and inability to absorb nutriments due to damage to the intestinal mucosa.

Lucas (1899) observed that the period of highest mortality occurred from about July 15 or 20 to August 20. Examination of 345 dead pups between July 23 and September 4 revealed hookworms in animals from all localities having favorable sandy soil, thus suggesting the parasite was an important factor in the mortality of pups.

Lucas believed that development of eggs continued in the intestine of dead pups and that eggs deposited on the rookeries hatched in a short time. Pups were thus exposed to ever-increasing numbers of larvae as the season progressed. It was his opinion that nursing pups became infected by swallowing larvae that were on the nipples, a conclusion based on finding fewer hookworms in starved than in well fed pups.

He believed that the low winter temperatures on the rookeries destroyed the eggs and larvae. Reinfestation, therefore, must come from the old animals although hookworms were not found in the ones that were examined.

The clinical symptoms, according to Lucas, included a rough coat and sleepy appearance, together with ill temper and a lack of vigor. Gross pathology included watery blood that was deficient in red corpuscles and would not coagulate in extreme cases. The anemic flesh was yellowish in color and differed from the dark purplish flesh of emaciated non-parasitized animals. The kidneys were anemic and soft. The worms usually appeared in the middle portion of the small intestine, but in severe cases they occupied almost the entire length. The large intestine was affected usually only in the upper end. The small intestine was nodular, pale, thick, and fragile. Small cyst-like spots occurred where the parasites were attached.

Stiles (1901) designated the hookworms as a new species, naming it *Uncinaria lucasi* in honor of Dr. F. A. Lucas.

Baylis (1943) described *U. lucasi* more fully, comparing it with *U. hamiltoni* Baylis, 1933, from a sea lion pup from the Falkland Islands and specimens from California sea lions (Baylis, 1933).

Scheffer and Kenyon (1944) raised the question as to whether adult fur seals carry a low-grade infection of *U. lucasi.*

Scheffer and Ashbrook (1949) and Day (1949) stated that hookworms were causing an increasingly greater mortality among newborn seals.

Price (1951) raised the question as to "whether infections in the pups is mainly due to overwinter survival of larvae, or whether, as is deemed more probable, it is mainly traceable to residual infection in adults.''

THE PROBLEM

The problem was to 1) ascertain the role of hookworms in the mortality of seal pups, 2) determine their life history and ecology, and 3) develop means of controlling them.

As a hypothesis, the following basic postulates were established: 1) the continued absence of information on hookworms in yearling and older seals suggested that these age groups are not infected, 2) if eggs and larvae could not survive the minimum temperatures on the rookeries during the winter, as was suspected, they could not initiate infections in newborn pups the following year, and 3) if adult seals are not infected and if eggs and larvae do not survive the low temperatures, a resident reservoir host must be assumed.

MATERIAL AND METHODS

In order to satisfy the first and third postulates, large numbers of fur seals, northern sea lions (*Eumetopias jubata*), and a few blue foxes (*Alopex lagopus*) were examined for adult hookworms. Seal intestines were obtained mostly from the three- and four-year old bachelors killed for their skins. Sea lions and foxes ranging in age from pups to old individuals were shot. Examinations for adult hookworms were made by slitting the entire intestine of about half of the seals and three-fourths of the sea lions and looking for them. In the remainder, feces from the large intestines were examined microscopically for hookworm eggs, using standard salt flotation techniques. The intestines of all the foxes were slit and scrutinized grossly.

Tests on the tolerance of eggs and larvae for cold were made by 1) exposing small packets of sand containing eggs and larvae to four different levels of temperature for varying periods, and 2) examining soil from rookeries early in the spring prior to the arrival of the seals from their winter sojourn at sea.

The unique life history was worked out while testing the efficacy of larvicides on the rookeries.

Numerous substances tested for larvicidal properties were applied to experimental plots on the infested rookeries. Different methods of application were employed, depending on the material used. They include spraying, injecting into the soil, and spreading in dry form. Twenty-nine different materials were used, only a few of which will be discussed. Test plots with treated and untreated control areas were utilized. The Baermann technique was used to separate larvae from the soil samples. Amounts of soil sampled for larvae ranged from the surface portion of an area 3 x 6 inches in the beginning, which was too much, to 50 grams later in the study.

Studies on the clinical symptoms and pathology included field and laboratory observations on sick pups. Pathological observations included blood and tissue studies together with gross and microscopic examinations.

Tests for infectious bacteria were made on over a dozen viscera from sick pups sent in a frozen condition to laboratories.

Observations on the frequency and degree of infection with hookworms in dead pups were made during the second week of August, 1955.

Because of the broad nature of this paper, methods and discussions of certain aspects of the study will be included in the subtopics in the section on Results of Investigations.

RESULTS OF INVESTIGATIONS

Determination of definitive host.—Of the fur seals, sea lions, and foxes examined, one adult sea lion and the pups of both sea lions and fur seals were infected with *U. lucasi.* No other species of hookworms were observed in the seals and sea lions.

Examination of 1,426 seals, ranging in age from yearlings to senile bulls failed to reveal any infections. Hookworms occurred frequently in the young seal pups. Examination of 553 dead pups picked up at random on six major rookeries between August 11 and 17, 1955, showed 66.3 per cent infected with hookworms.

Inasmuch as sea lions are closely related to the fur seals and frequently go to the seal rookeries throughout the year, examinations were made to determine whether they might be infected and thereby serve as reservoir hosts of hookworms. One subadult male, of 70 yearling and older animals examined, harbored *U. lucasi.* Thus adult sea lions are infected occasionally (1.4 per cent of the number examined) and may serve in an extremely limited capacity as reservoir hosts. They appear to be of no practical or biological significance in maintaining the hookworm population. Of 41 young pups examined, 36, or 87.8 per cent, were infected. On Walrus Island in the Pribilof group where sea lions are abundant but where seals have not been known to occur, the single sea lion pup examined harbored *U. lucasi.*

Blue foxes are resident on the islands and spend a great deal of time on the rookeries. Of 16 foxes, adults and pups, from St. Paul examined by the writer and 18 from St. George examined by Ransom (1919), none was infected with *U. lucasi.* Twelve of the foxes from St. Paul and none from St. George were infected with ***U. stenocephala,*** the fox hookworm. Apparently foxes do not serve as a reservoir host of *U. lacasi.*

Experimental infection of seal pups with hookworm larvae.—Numerous attempts were made to establish experimental infections in seal pups by exposing them to large numbers of third stage larvae hatched from eggs collected from the intestines of both seal and sea lion pups.

The points of exposure were 1) the mouth, 2) the stomach, 3) shaved and unshaved skin of the abdomen, 4) both the dorsal and ventral unhaired surfaces of the flippers, 5) the hairy regions at the base of the flippers, 6) the thinly haired, soft perineal skin, 7) the vagina, and 8) the rectum. No conclusive evidence was obtained that an infection was established, judging from the magnitude of the exposure and the number of hookworms recovered at necropsy.

Larvae are capable of penetrating the skin, as shown experimentally. Pieces of skin from recently killed seals were stretched loosely over beakers so that the flesh side was in contact with water kept at body temperature. Large numbers of third stage larvae were pipetted onto the outer depressed surface of the skin. After approximately three hours, each piece of skin was removed and the larvae in the bottom of the beakers were counted. Three larvae passed through the soft nearly hairless perineal skin, 10 through the unshaved belly skin, and hundreds through the flipper skin. Larvae which had not passed through the skin were recovered from the surface of it. The haired skin was from pups and the flipper skin from both pups and a senile bull seal. The porous flippers (Bartholomew and Wilke, 1956) appear to constitute a more favorable avenue of entrance than the skin of the body. It is not clear why experimental infections could not be established in the pups. Perhaps the larvae require a longer period than that allowed to become infective after reaching the third stage.

Survival of hookworm eggs exposed to various temperatures.—Unincubated hookworm eggs were thoroughly mixed with sand preparatory to exposure of varying temperatures. Fifty grams of the sand containing the eggs were wrapped in plastic bags to prevent drying and exposed to temperatuers of 44 to 46° F, 24 to 26° F, 16 to 18° F, and —4 to —5° F. Groups of packages were exposed for 14, 28, and 42 days in each of the three higher temperature ranges and for 24 hours and multiples thereof up to 144 hours, or six days, in the fourth and lowest temperature.

Eggs survived the first three temperature ranges as indicated by larvae that hatched at the end of each period of exposure but in decreasing numbers as the duration of the exposure lengthened and the

TABLE 1. SURVIVAL OF HOOKWORM EGGS AT VARIOUS TEMPERATURES

Degrees F	Days of exposure 14	28	42
	Surviving larvae per gm. of sand		
	(No.)	(No.)	(No.)
44-46	57	4	0.5
24-26	20.8	35.1	17.3
16-18	0.21	2.3	1.4
−5	0	0	0
Controls at room temperature	?	?	121

temperature decreased. Survival in the subzero temperature was less than 24 hours. The results are given in Table 1.

Survival of hookworm larvae exposed to various temperatures.—Third stage larvae hatched from eggs incubated in the laboratory were exposed simultaneously with the eggs under the same conditions. Many survived at temperatures of 44-46° F and 24-26° F for 42 days but none at 24-26° F for 42 days nor 24 hours at —4° F (Table 2).

Notwithstanding the inability of larvae to survive —4 to —5° F in small packages of sand placed in a deep freeze unit, nor to withstand higher temperatures without a high rate of mortality, they survive the winters in great numbers on the rookeries where air temperatures of —26° F have been recorded.

Life history.—The life history of *U. lucasi* had been assumed to be similar to that of *U. stenocephala* and other hookworms in that the adult worms occur in the hosts at all times. When it was discovered, however, that 1) adult seals are not infected, 2) pups only are infected, 3) a reservoir host is not required, and 4) larvae survive the winter on the rookeries during the absence of the seals, it became clear that the infections are present in the young pups of fur seals and sea lions only during the first few months of their lives. The remainder of the time the hookworm population exists as eggs or larvae on the rookeries.

TABLE 2. SURVIVAL OF THIRD-STAGE HOOKWORM LARVAE AT VARIOUS TEMPERATURES

Degrees F	Days of exposure 14	28	42
	Surviving larvae per gm. of sand		
	(No.)	(No.)	(No.)
44-46	306.1	441.7	341.4
24-26	201	382.8	339.5
16-18	2.47	0.22	0
−5	0[1]	0	0
Controls at room temperature	?	?	[2]

[1]Did not survive 24 hours
[2]About same as 44-46° F

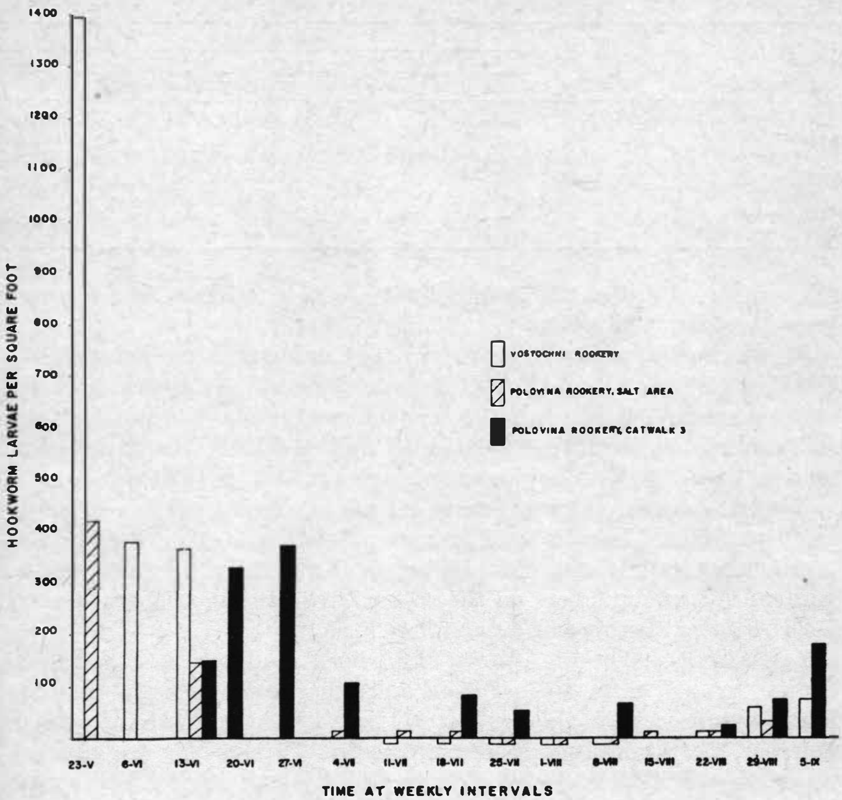

Figure 1. Weekly counts of hookworm larvae on four different areas showing the early spring population, its decline, disappearance, and the appearance of a new generation resulting from the hatching of eggs deposited during the summer. The absence of an histogram indicates that no soil samples were taken that week. The appearance of an histogram below the abscissa indicates the absence of larvae from the samples.

This condition where only the young are infected is unique among the hookworms, indeed, among nematodes, insofar as is known.

The exogenous phase of the life cycle has been clarified through field and laboratory observations. In the spring, large numbers of infective larvae are present in the soil of the rookeries when the seals arrive and the pups are born. Entrance of larvae by mouth or through the flippers, and possibly other parts of the body, probably occurs in both adult and newborn seals. Those entering the adult are destroyed while those entering the pups develop to maturity.

As the summer progresses and the seal population on the rookeries increases, the number of larvae appearing in the soil samples steadily decreases until about the first week in August when none can be found even with extensive sampling. Infected pups pass large numbers of eggs onto the rookeries throughout the summer, which do not begin to hatch until about the first week in September. At this time, larvae reappear in the soil samples. They increase steadily in number until about the middle of September when sampling was discontinued.

A few larvae remained on one area throughout the summer where seals were kept off (Fig. 1). Larvae are most abundant when the seals arrive in the spring and therefore the eggs would be expected to be least numerous. The reverse becomes true by early September. The exogenous phase of the life cycle is portrayed in Figure 2.

Each generation of pups is parasitized by larvae hatching from eggs deposited by pups of the preceding generation. By the time hatching begins in September, most of the pups are spending the major part of their time in the sea and along the immediate shore line.

The reason for retardation of hatching of the eggs is not clear. It does not seem to be the result of low temperature as hatching takes place later when cooler weather prevails. Diurnal temperatures in

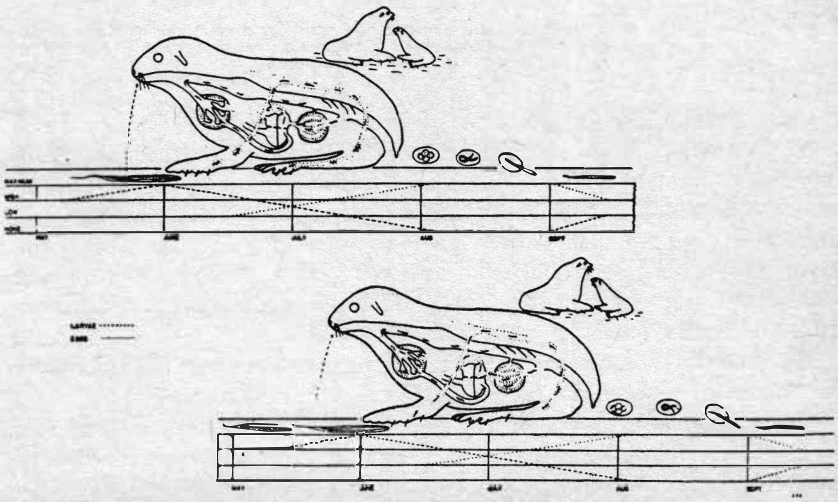

Figure 2. Life history of *Uncinaria lucasi,* showing the probable endogenous and exogenous phases. Third stage larvae entering the skin must migrate by way of the liver, heart, lungs, trachea, oesophagus, and stomach to reach the small intestine to mature. Larvae swallowed by the pups may develop to maturity in the small intestine without migration. Larvae entering adult seals are destroyed, thus preventing development.

Larvae are abundant on the rookeries in the spring but gradually decline in numbers until August when they can no longer be recovered from the sand. While large numbers of eggs are passed on to the rookeries by the pups, hatching does not begin until the first week in September when a new generation of larvae which lives over the winter appears. It infects the next generation of seal pups the following summer.

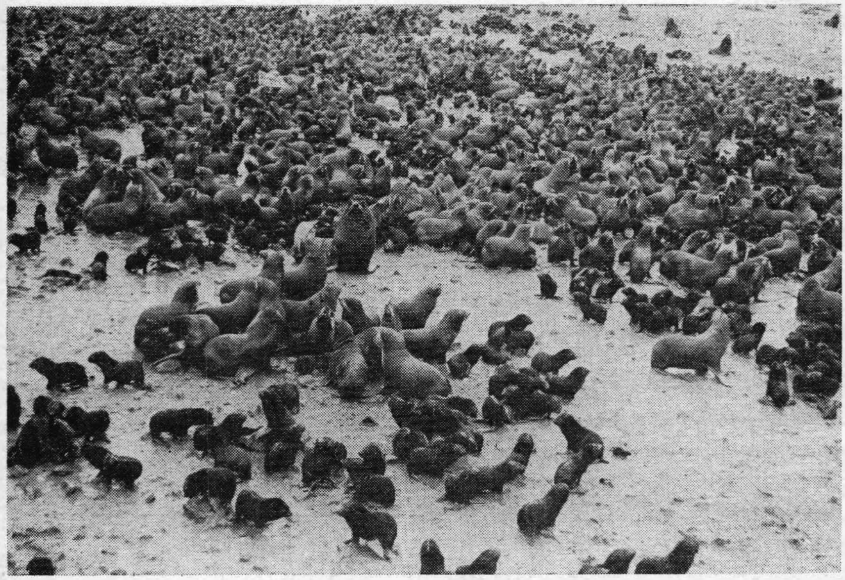

Figure 3. The density of the seal population on the rookeries during the height of the breeding season reaches a point of saturation which situation is favorable to the spread of hookworms.

the upper half inch of soil from July 1 to August 14, 1954, ranged from 51 to 85° F. Nocturnal temperatures were not recorded. Delayed development and hatching on the rookeries may be associated with the abundance of decomposing organic residues such as feces and urine resulting from the dense population of seals (Fig. 3). The upper layer of sand becomes encrusted and very hard. When the impacted sand containing eggs is broken up and placed in the laboratory, larvae appear. Similar controls were not kept outside.

Eggs collected from the intestine of pups hatched in nine days in the laboratory where the temperature ranged from 58 to 70° F.

The endogenous phase of the life cycle has not been determined completely. While some parts of it are obvious, others are not supported by observations.

Experimental evidence indicated that the infection may take place through the skin, especially the porous skin of the flippers. This would necessitate migration through the lungs. Infection may occur through the mouth by swallowing larvae with infested sand. This route may not require migration through the lungs. It should be recalled that experimental exposure of pups to third stage larvae failed to establish a convincing infection. Fülleborn (1926) found that larvae of *U. stenocephala* could develop in dogs without migration through the lungs. Foster and Cross (1934) observed a similar situation with *Ancylostoma caninum* in dogs.

Migrating larvae were not recovered from Baermannized or artificially digested liver and lung tissues from a few parasitized seal pups from heavily infested rookeries. Neither were larvae found in several fresh placentae treated in a similar manner. The possibility of prenatal infections exists, especially in view of the fact that larvae were observed to pass in great numbers through the skin of the flippers. Fetal pups were not readily available to determine this point. Prenatal infection of canine pups with hookworms (Adler and Clark, 1922; Foster, 1932) and ascarids (Fülleborn, 1921; Augustine, 1927; Nifontov, 1949; Sprent, 1954, Webster, 1956) and of silver foxes (Petrov, 1941) is common even when the bitches or vixens are uninfected with adult worms.

The time required for these hookworms to reach sexual maturity in the seals has not been established. Fülleborn (1926) found it to be 21 days for *U. stenocephala* in experimentally infected dogs. The probable life cycle is illustrated in Figure 2.

Probable role of adult seals in reducing the degree of infection in pups.—Considering the facility with which hookworm larvae pass through the skin of the flippers of adult seals, it is highly probable that great numbers of larvae enter them. Once inside the body, they are destroyed as indicated by the absence of hookworms in adult seals. Thus the adult seals which outnumber the pups (Fig. 3) and which have far larger areas of flipper exposed to the ground may take up many more larvae per unit of time of exposure than do the pups. If this probability obtains, the presence of adult seals on the rookeries serve to reduce the number of larvae and thereby protect the pups from even heavier infections than now occur.

Physiology and ecology of eggs and larvae on the rookeries.—It is obvious that the eggs and larvae are sufficiently resistant to cold to survive the low temperatures in the microclimate where they spend the winter. So far as is known, larvae do not seek protection from the cold by migrating deeply in the sand. They have been recovered late in May from the surface layer of soil under as much as 4.5 feet of snow and ice, which insulates them against extremely low temperatures.

The period of time over which hatching occurs is probably a prolonged one, beginning in September and extending through the fall and winter, being completed in the spring. The pattern of gradual decline of the number of larvae on the rookeries during the summer, leading to complete disappearance of them in August, is interpreted as evidence that hatching takes place over a long period.

While the longevity of the eggs or the larvae is unknown, the length of time between the deposition of the last eggs on the rookeries and the disappearance of the last larvae in August is approximately 10 to 11 months.

PATHOLOGY

Observations were made on the pathological conditions in sick pups. They include 1) clinical observations, 2) gross observations on the physical condition of the intestine of parasitized pups, 3) examination of the blood for volume and morphology of the erythrocytes, and the amount of haemoglobin, 4) microscopic examination of sectioned tissues for pathological changes, and 5) bacteriological examination of viscera of sick pups for the presence of recognized pathogenic organisms.

Clinical symptoms.—The common clinical symptoms shown by pups suffering from uncinariasis are associated with anemia. They include blanched mucous membranes, dyspnea, and weakness. During forced exertion, as when being driven on land, anemic pups frequently exhibit marked weakness. They quickly fall behind the pod, often collapsing. Dyspneic respiration is very evident. Following recovery after a short rest, they try to rejoin the other seals often with recurrence of exhaustion. Bloody feces containing great numbers of hookworm eggs appear commonly, beginning early in the season and continuing until late in the summer.

Gross appearance of the small intestine.—Like the mucous membranes, the wall of the parasitized intestine is anemic. It is thickened and extremely fragile, breaking under slight tension. The hookworms often occur in groups at which point an enlarged nodule appears. Petechiae appear over the surface of the mucosa in the parasitized area. In heavily infected animals, much free blood occurs in the lumen of the intestine.

Heavily parasitized dead animals commonly are fat and in excellent physical condition.

Blood.—Observations on the blood were limited to 71 pups. They included parasitized animals in all stages of physical conditions, as well as healthy unparasitized ones and emaciated ones. Since all of the observations did not lend themselves to a complete study due to shortage of suitable equipment or time when the examinations were made, they will be considered as 1) red cell volume and haemoglobin values, 2) red cell volume and number, and 3) study of stained slides.

In all cases, the number of worms is included and considered as a part of the picture.

Red cell volume and haemoglobin values were made with haematocrit tubes and a Sahli-Hellige haemoglobinometer on 51 pups. This group included eight apparently healthy, unparasitized pups. The remaining 43 exhibited clinical symptoms in varying degrees. Three were without hookworms and 40 had 4 to 435 each (Table 3).

In the apparently healthy group, two pups had 22 and 23 per cent red blood cells and 36 and 40 per cent of haemoglobin, whereas in the others, they ranged from 33 to 44 per cent red blood cells and 66 to 78 per cent haemoglobin. The reason for the low blood values in the two unparasitized pups is unknown. Obviously it was not associated with hookworms.

In the parasitized pups, anemia and large numbers of hookworms generally were associated, though puzzling exceptions occurred. For example, one pup with 12 per cent red blood cell volume had an estimated 50 worms as contrasted with one having 29 per cent red blood cells and 125 worms, or two having 22 per cent red blood cells where

TABLE 3. RELATIONSHIP BETWEEN THE NUMBER OF HOOKWORMS AND ANEMIA BASED ON RED BLOOD CELL VOLUME (HAEMATOCRIT) AND HAEMOGLOBIN VALUES (SAHLI-HELLIGE) IN 51 SICK AND HEALTHY PUPS, ARRANGED IN ASCENDING PROGRESSION OF THE RED CELL VOLUME.

No. of pups	Number of hookworms[1]	Per cent of RBC	Per cent of haemoglobin	Physical appearance of pups
1	435	8.5	22	a, f[3]
2	200, 300	10	15-25	f, g, c; f
4	75, 100, 175, 200	11	17-20	c, f, g; c, f, g; ?; f, g
1	50	12	36	c, f, g
4	100, 125, 125, 250	13	21-30	c, f, g; c, e, f, g; c, f, g; c, f; f
2	150, 300	14	20-21	c, e, f, g; c, f, g
1	300	15	24	c, f, g
2	100, 150	16	25	c, f, g; c, e, f, g
5	4, 10, 30, 100, 125	17	23-34	c, d, e, f, g; c, f, g; c, f, g; c, f, g
2	15, 20	18	30	c, f, g; c, f, g
2	20, 25	20	40	c; c, g
1	25	21	35	c, f, g
2	0, 175[2]	22	30-36[2]	a; a, f, g
1	0	23	40	a
2	15, 50	24	44-50	b, f, g; c, g
3	5, 75, 125	25	40-47	c, g; c, f, g; c
1	0	27	50	c
1	125	29	58	c, f, g
1	0	31	64	c
2	0, 10	33	66	a; c
2	0. 0	35	72-74	a; a
1	0	36	60	c, f
2	0, 4	38	73	a; c, f
2	0, 0	41	80-84	b; a
1	0	42	82	a
2	0, 0	42	80	a; a
1	0	44	78	c

[1]Numbers were estimated after washing worms from the intestine onto a screen except the first pup which was an actual count.
[2]Sick pup.
[3]Key: a, good physical condition; b, fair physical condition; c, poor physical condition; d, blood in intestine; e, nodules in intestine; f, anemic intestine; and g, weak.

TABLE 4. RELATIONSHIP BETWEEN THE NUMBER OF HOOKWORMS, NUMBER OF RED BLOOD CELLS PER ML OF BLOOD, AND VOLUME OF PACKED RED BLOOD CELLS IN 12 SICK SEAL PUPS

Number of hookworms	Blood values: Millions of RBC per ml[1]	Blood values: Per cent of packed RBC	Physical appearance of pups
294	0.655	11	a, e[2]
265	0.870	16	c, d
575	1.185	13	a, d
230	1.575	15	b, d
129	1.620	18	b, d
266	1.635	16	b, d
5	1.737	16	e, f
9	1.800	16	g
27	2.299	22	a
175	2.310	14	a, d
1	3.090	27	c
115	3.240	18	a, e

[1]Counts made by Dr. W. L. Jellison (1951).
[2]Key: a, good physical condition; b, fair physical condition; c, poor physical condition; d, blood in intestine; e, nodules resulting from hookworms that had been eliminated; f, peritonitis; and g, pus in nasal passages and throat.

one had no hookworms and the other had 175. In the latter case, the sick, parasitized pup had 30 per cent haemoglobin as compared with 36 per cent for the unparasitized one. Three unparasitized, sick pups had high red blood cell volumes of 27, 31, and 36 per cent.

The number and volume of red blood cells were observed in 12 sick pups to further ascertain the extent to which anemia might be correlated with hookworms in seal pups. The number of red blood cells per ml of blood ranged from 655,000 to 3,240,000 and the packed cell volume from 11 to 27 per cent. The number of hookworms varied from 1 to 575 (Table 4). In general, there is good correlation between the number of hookworms or evidence, in the form of nodules, of their having been present in the intestine. All except two were either heavily infected and had blood in the intestine or showed proof of earlier heavy damaging infections. One had five hookworms, many intestinal nodules, and severe peritonitis, and another had one hookworm, many nodules, and much pus in the nasal passages and throat.

Exceptions occurred, however, with anemia existing where there was no evidence of serious hookworm infection. Two pups with 27 and one hookworm each had 2,299,000 (22 per cent packed cell volume) and 3,090,000 (27 per cent) red blood cells per ml, respectively.

The data presented in these tables indicate that variable and complicating factors are associated with the blood picture of sick pups. Two things, however, are apparent. They are 1) anemia may result from causes other than hookworms, and 2) when associated with hookworms, it varies greatly, doubtless due to these other complicating factors.

Severity of anemia and the number of hookworms present at the time of examination may not show any apparent relationship. Indeed,

TABLE 5. DISTRIBUTION OF HOOKWORMS IN APPARENTLY SICK PUPS ON ST. PAUL ISLAND

Number of		Per cent
Pups	Hookworms	Pups
17	0	21.8
19	1-88	24.4
42	115-900	53.8
Total 78	15,218	100.0

it frequently appears that none exists! If the condition is interpreted on the basis of the stage of development of the infection, a feasible explanation for some of it is forthcoming. For example, heavy infections acquired quickly may have had sufficient time when observed to have produced only a benign anemia. Thus a blood condition contrary to that expected from a heavy infection would appear. On the other hand, in cases where heavy infections have been eliminated recently, severe anemia may exist with no apparent relation to worms.

Dehydration of pups might alter the blood picture to one inconsistent with that expected from the degree of parasitism present.

Stained blood smears from nine pups with infections ranging from 1 to 575 hookworms showed morphological evidence in the erythrocytes of anemic conditions. These included 1) an increased number of erythroblasts and normoblasts, 2) anochromia, or subnormal amount of haemoglobin, and 3) anisocytosis, or variation in the size of erythrocytes.[1]

While anemia definitely is a part of uncinariasis in seal pups, it occurs also in connection with other factors unrecognized at this time.

Tissue pathology.—The limited observations on tissue pathology indicate that hookworms cause severe injury. Great damage occurs in the lower part of the small intestine and in the upper part of the large intestine and caecum. It is manifested by destruction of the mucosa and pronounced changes in the submucosa as deep as the muscularis. Ulceration, edema, and infiltration by monocytes and neutrophils occur. The severe inflammation develops into abscessed and necrotic areas. Other tissue damage observed is cloudy swelling of the hepatic cells to the extent that liver sinusoids are occluded, together with damage to the convoluted tubules of the kidneys.[2]

Bacterial infections.—Three types of bacterial organisms were recognized either directly or indirectly.

[1]These observations were made by Dr. Maxine Benjamin, Colorado State University, College of Veterinary Medicine.
[2]Pathological observations were made by Dean Rue Jensen, Colorado State University, College of Veterinary Medicine.

Filamentous necrophorous-like bacteria were observed in sections of the small intestine.[1]

Bacteria isolated from frozen viscera at the Microbiological Institute at Hamilton, Montana, were tentatively identified as *Salmonella*. When injected into mice, they produced morbidity followed by death (Jellison, 1952).[2] Another set of 10 viscera from sick pups examined at Colorado State University, College of Veterinary Medicine, failed to show bacteria.[3]

Indirect evidence of bacterial infections appeared in the blood smears. A marked increase in the leucocytes in the blood smears of two pups was interpreted as evidence of bacterial infection.[4] Sections of two lymph nodes of undesignated location showed acute lymphadenitis with neutrophils and macrophages filling the sinuses, resulting from drainage of an area of inflammation. Sections of one lung showed scars of bronchopneumonia that had healed and become reorganized.[1] Peritonitis was observed in a few cases.

Damage by hookworms to the intestine and lungs might serve as avenues through which necrophorus organisms together with pneumonia- and peritonitis-causing bacteria enter the tissues.

PROBABLE RELATIONSHIP OF HOOKWORMS TO MORTALITY OF SEAL PUPS

While it has been assumed that hookworms are responsible for the great mortality of young seal pups, the matter has never been investigated extensively. It is difficult to conduct a study of this nature during the period when the young are being born and the harems are well organized because of undue disturbance of the seals. Only after the harems have disbanded have dead or sick pups been examined in suitable numbers. By this time, the major seasonal die-off has passed and the extent of parasitism in the pups may not be the same as earlier in the season when the hookworm larvae are numerous in the soil. In fact, there are reasons to believe that a marked difference exists.

Incidence of infection in live sick pups.—Of 78 pups chosen on infested rookeries for postmortem examination in 1951 on the basis of their appearing sick, 17, or 21.8 per cent, were free of hookworms. The infected ones harbored from one to 900 worms (Table 5). Burdens of 100 or more worms appear to be correlated with anemia, as pointed out elsewhere in this paper.

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[1]Identified by Dean Rue Jensen.

[2]Since this manuscript went to press, Jellison and Milner (1958). Jour. Wildlife Mgt. 22: 199-200) reported that *Salmonella enteritidis* (Gaertner) has been isolated from the blood and viscera of seal pups, and from seal lice (*Anarctophthirus callorhini* (Osborn) and *Proechinopthirus fluctus* (Ferris)). The presence of *S. enteritidis* establishes another probable cause of mortality.

[3]Examined by Dr. R. Scott Jackson, formerly of Colorado State University, College of Veterinary Medicine.

[4]Examined by Dr. Maxine Benjamin.

TABLE 6. FREQUENCY AND DEGREE OF INFECTION BY HOOKWORMS OF SEAL PUPS THAT HAD DIED SHORTLY PRIOR TO THE TIME OF EXAMINATION IN THE MIDDLE OF AUGUST, 1955

Rookery	Frequency and degree of infection: No infections		Light infections		Moderate to heavy infections		Total examined
	No.	Per cent	No.	Per cent	No.	Per cent	No.
Reef	36	73.5	11	22.4	2	4.1	49
Kitovi	23	82.2	4	14.3	1	3.5	28
Tolstoi	27	27	27	27	46	46	100
Zapadni	33	27	35	35	32	32	100
Polovina	44	26.8	71	43.3	49	29.9	164
Vostochni	23	20.5	33	29.4	56	50	112
Total	186		181		186		553
Per cent		33.6		32.7		33.6	

Incidence of infection in dead pups.—In 1955, a total of 553 pups found dead on six rookeries was examined grossly for hookworms. On two of the rookeries (Reef and Kitovi), 73.5 and 82.2 per cent of 49 and 28 pups, respectively, were free of hookworms whereas 4.1 and 3.5 per cent were moderately to heavily infected. On the four remaining rookeries (Tolstoi, Zapadni, Polovina, and Vostochni), where hookworms abound, 20.5 and 27 per cent of the pups were without hookworms while 29.9 to 50 per cent were judged as being moderately to heavily infected, having what were estimated to be 50 or more worms each. The over-all picture showed 33.6 per cent of the pups without hookworms, 32.7 per cent lightly infected, and 33.6 per cent moderately to heavily infected (Table 6).

From the few dead pups retrieved from the harems early in the season, two yielded 1,500 adult hookworms each, based on aliquot counts. From a total of 631 sick and dead pups examined late in the summers, none has approached this number of hookworms, the nearest being 900 in one live but very sick animal.

From these observations, it appears that hookworms are not the cause of death in some pups and may be only a contributing factor in others. In heavy infections, it is highly probable that they are responsible for the death of the pups. The full relationship of hookworms and pup mortality still is not established.[1]

RESISTANCE OF MAN TO INFECTION BY *Uncinaria lucasi*

Humans appear to be resistant to the larvae of hookworms of seals. Continuous handling of infested sand both on the rookeries and in the

[1]Upon postmortem examination of 1804 dead seal pups, Doyle (1957 Investigation of Death Losses in Fur Seal Pups on St. Paul Island, Alaska, June 28 to August 15, 1957, U. S. F. & W. Service, Seattle) found that death in the early part of the season was due largely to injuries, starvation, and bacterial infection. As the season progressed, hookworm infection became more important and was the cause of about 60 per cent of the deaths.

laboratory over a period of five summers failed to result in any cases of creeping eruption or prickling sensations indicating penetration of larvae into the skin. Experimental exposure of the hands, wrists, and forearms to third stage larvae failed to give evidence of skin penetration. No cases of creeping eruption are known to have occurred at any time in the people on St. Paul Island.

This is quite different from Fülleborn's (1927) experience with the larvae of *U. stenocephala* where creeping eruption developed readily from experimental exposure of his own body and that of a colleague.

CONTROL OF HOOKWORMS

The only conceivable approach apparent at present for controlling hookworms in the fur seal herds is destruction of larvae in the soil of the rookeries during the absence of the seals.

Up to the present time, attempts at destroying them have been by applying larvicidal substances to the soil. These include solids, certain fumigants, and sprays.

Solids.—Sodium chloride applied at rates up to one pound per square foot failed to destroy larvae.

Borons,[2] including Polybor-2, containing 78 per cent sodium pentaborate and 20 per cent tetraborate, Colemanite, containing 28.9 per cent boron trioxide, and Borascu, or Anhydrous Rasorite, containing 19 per cent boron trioxide, were used. Larvae were still abundant in the spring on plots to which 0.05, 0.1, and 0.2 pounds per square foot of each of these compounds had been applied the preceding fall.

Fumigants.—Nematicides used in controlling plant-infesting nematodes were tested on a limited basis. These included Dowfume W-85 (83 per cent ethylene dibromide), Dow SCR 35405 (compounds not disclosed), Shell D-D (1,3-dichloropropane), and Shell Nemagon (1,2-dibromo-3-chloropropane). When used according to instructions for controlling plant nematodes, these componds failed to destroy the hookworm larvae on experimental plots. Further trials, however, with these and other similar nematicides should be made, using equipment designed for applying them to the rookeries to destroy hookworm larvae.

Sprays.—Promising chemicals used to date include coal tar cresol and cresylic disinfectant. Five per cent aqueous emulsions containing 0.03 per cent commercial wetting agent applied under pressure at the rate of one pint per square foot gave excellent results on experimental plots (Fig. 4). Cresylic disinfectant was selected for spraying an area of about three acres in 1956.

[2]Supplied through the courtesy of the Pacific Borax Company.

Figure 4. Application of 5 per cent cresylic disinfectant at the rate of one pint per square foot was on a time-area basis. In two minutes. 440 pints were applied to an area 8 by 55 feet (440 square feet) through a specially constructed spray head. Force, which in this case was provided by a pump powered by a small gasoline engine, is necessary to drive the jets of emulsion into the soil to assure better wetting of it.

The experimental plots were 4 by 20 feet in size. One half (4 by 10 feet) of each plot was sprayed with cresylic disinfectant and the other half was left unsprayed to serve as a control in determining the efficacy of the treatment.

The number of hookworms in the sprayed and unsprayed plots was determined by baermannizing 50 gram samples of soil in 7- and 10-inch funnels. In order to compensate for the inefficiency of the Baermann procedure in removing larvae from the soil, as pointed out by Dinaburg (1942), numerous small samples of soil were examined. After the samples of soil had been in the funnel over night, the screens containing them were removed and the water stirred by a circular movement. This action was used to dislodge larvae from the sides of the funnel and to direct them to the center of the vortex and into the stem of the funnel. Larval counts were made over a period of four weeks from samples of soil collected on the unsprayed and sprayed portions of 10 experimental plots.

The gauze pads recommended by Beaver (1953) for obtaining larval hookworms of man and dogs from the soil were unsuccessful in these studies.

From 390 samples obtained on the unsprayed control plots, 8,934 larvae were recovered. They came from 366 samples, leaving 24 without larvae. The mean number of larvae for each of the 390 samples was 22.9 and for each of the 366 positive ones was 24.4.

From the sprayed portion of the plots, 572 samples were examined. Of these, 483 yielded no larvae. From the 89 positive ones, 137 larvae, ranging from 1 to 58 per sample, were obtained. The mean number of larvae for each of the 572 samples was 0.24 and for each of the 89 positive ones was 1.54.

Cresylic disinfectant therefore effected a great reduction of larvae. Of the samples from the unsprayed areas, 93.8 per cent were positive for larvae as compared with 15.5 per cent from the sprayed plots. The mean number of larvae per sample of unsprayed soil was 22.8 for all 390 samples compared with 0.24 for 572 samples from the sprayed areas, a decrease of 98.9 per cent. In the infested samples, the mean number of larvae from unsprayed plots was 24.4, and in the sprayed areas it was 1.54, a reduction of 93.4 per cent.

Although a great reduction of larvae was effected by the spray, it was not reflected by reduced mortality of pups on the large treated area (Abegglen, Roppel, and Wilke, 1956). Due to discontinuance of the work, no examination of dead pups was made to determine the extent of parasitism in them following application of the 5 per cent cresylic disinfectant under pressure in 1956. It appears that either more larvae are surviving than the Baermann technique is capable of measuring or some other factor or a combination of factors are operating to cause the mortality. Such factors might include starvation, injury, bacterial or viral infection, stress from crowding, and others.

DISCUSSION

At the outset of this study, it was thought that hookworms might be the principal cause of the mortality among pups. They doubtless still stand high among the factors leading to the death of many pups. It now appears, however, that a number of other causes enter into the picture. Some of these are recognizable. They include starvation, suffocation in storms, and trampling by the bulls. Others which might be expected but are unrecognized at this time include bacterial and viral diseases, exposure to chilling rains, crowding, congenital deficiencies, and possibly overeating when the cows return to the rookeries after a prolonged period of foraging at sea. While direct evidence of death from overeating is lacking, the extent to which the pups engorge themselves suggests that interference with heart action may result. In the absence of studies to isolate, determine, and evaluate these causes, certain suppositions relative to them are offered.

As pointed out by Lucas (1899), mortality appears to be higher on sandy rookeries than on non-sandy ones. Because of the difficulty in determining the percentage of pups that die on the different rookeries, this statement still stands. Stiles and Hassall (1899) postulated that hook worm disease might be severe, especially on sandy rookeries where a better environment is provided for the developing eggs and larva. Our observations have indicated a greater number of infected pups with heavier infections and greater mortality on the sandy rookeries. This condition corresponds to recent observations on hookworms of man in the southern United States where a higher frequency and degree of infection are correlated with sandy loam areas (Andrews, 1942).

There is evidence, however, that factors other than hookworms are causing mortality. Of the dead pups examined on two non-sandy rookeries, 73.5 and 82.2 per cent were uninfected and 22.4 and 14.3 per cent were lightly infected. On the four sandy rookeries, 20.5 to 27 per cent were without hookworms and 23 to 29.5 per cent were lightly infected. In the total of 553 dead pups examined during August 1955, 33.6 per cent were without hookworms and 32.7 per cent were lightly infected (Table 5). Thus, some factor or set of factors on the non-sandy rookeries are operating to prevent the hookworm population from building up equal to that on the sandy ones. In the case of hookworms of man in the southeastern United States, clay soil prevents the development of high larval populations and, therefore, the people have fewer hookworms even under unsanitary conditions (Andrews, 1942).

If the non-sandy rookeries may be used as a criterion for pup mortality principally from causes other than hookworms, the causes of death may be sought more readily on them than on the heavily parasitized ones.

If it be conceded that such conditions as starvation, trampling, infectious diseases, exposure, and congenital deficiencies, and possibly overeating may be causes of death, they would be expected to appear equally on all rookeries. Similarly, it would be expected that in areas where hookworms are numerous and 50 per cent of the pups are moderately to heavily infected, a greater percentage of the population of young seals would succumb because of the combined effect of uncinariasis and other factors. Thus, while other factors are believed to be associated with mortality of pups, such a pathogenic organism as hookworms occurring in great numbers must not be overlooked.

Treatment of experimental plots with cresylic disinfectant to destroy the infective larvae gave such encouraging results that larger areas were sprayed in the hopes of reducing that portion of the pup mortality caused by hookworms. These expectations were not realized upon enumeration of the dead pups of the season. In seeking the reasons for the failure, several facts must be considered, assuming hookworms to be a significant factor either directly or indirectly in the pup mortality. They are 1) greater numbers of hookworm larvae survive under large scale spraying operations, which were always conducted by inexperienced and untrained personnel, than on small experimental plots where close attention could be and was given to every detail of application, 2) the sampling techniques employed may not be sufficiently sensitive, thereby giving a false impression of the efficacy of the larvicide used, and 3) the larvicide may not have destroyed as many larvae as the tests indicated, thus leaving enough of them even though greatly reduced in number to produce disease and mortality.

On the other hand, as already mentioned, the possibility of other causes, either pathogens or ecological factors or both, must be considered in the face of the evidence presented in this study. They should be sought, recognized, and managed as best they can. Regardless of them, however, such a well understood and recognized pathogen as the hookworm whose presence is known should not be disregarded in any sound management plan for animals having the gregarious and homing instincts of the fur seals.

Further studies should be conducted on the larvicidal efficacy of Dowfume W-85, D-D, and other nematicides used successfully against nematodes infesting crops. Special equipment need be developed for application to produce greatest efficiency against hookworm larvae and to give adequate protection to personnel applying it.

SUMMARY

1. The hookworm, *Uncinaria lucasi,* is the only helminth occurring in the pups of fur seals and sea lions.
2. No infections were found in 1,426 seals ranging from yearlings to senile adults.
3. One subadult bull sea lion among the 70 yearling and older animals examined was infected with *Uncinaria lucasi.*
4. Blue foxes on St. Paul Island harbored *U. stenocephala* but not *U. lucasi.*
5. Attempts to establish experimental infections with larvae hatched in the laboratory were not conclusive.
6. Larvae readily penetrate the porous skin of the flippers of both

pups and old seals but only slightly the skin on the other parts of the body.

7. Larvae survive the winters and are present in the sand in great numbers in the spring.

8. The life history of *U. lucasi* is unique. Newborn pups are infected by larvae that survived over the winter in great numbers from eggs deposited the preceding summer. Sexual maturity seems to be reached in about three weeks after the larvae enter the pups. Large numbers of eggs are deposited during the summer. Larvae gradually decrease in numbers on the rookeries until the first week in August when they disappear until the first week in September, at which time hatching of the eggs deposited during the summer begins. These larvae survive the winter and are the source of infection of the next generation of seals.

9. Large numbers of hookworm larvae probably enter adult seals but are destroyed before reaching the intestine.

10. The common clinical symptom of uncinariasis is anemia with its characteristic syndromes.

11. The pathology includes a fragile intestine and watery blood having the characteristic morphological features of anemia.

12. *Salmonella* was isolated from the viscera of one seal but not from those of 10 sick pups of another lot.

13. Tests were not made for viral diseases.

14. Of 553 dead pups examined, one third had no hookworms, one third had light infections, and one third had moderate to heavy infections.

15. Infections ranged up to 1,500 worms per pup early in the season.

16. Man is resistant to infection by *U. lucasi.*

17. Five per cent cresylic disinfectant with 0.03 per cent wetting agent sprayed under pressure at the rate of one pint per square foot gave excellent results on experimental plots but failed to reduce pup mortality when sprayed on a large area.

18. Borons, including Polybor-2, Colemanite, and Borascu, failed to destroy larvae.

19. Time did not permit adequate tests with nematicides used successfully in controlling nematodes that destroy crops.

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DISCUSSION

DISCUSSION LEADER DYKSTRA: We are indebted to Dr. Olsen for pointing out the tremendous importance of some wildlife diseases as mortality-producing factors in species that we want to propagate in large numbers. We are also indebted to him for the detailed study he has made and is making of the life history of these animals so that we can find some weak point through which to attack the problem. Even though the preliminary findings seem to be a bit discouraging, it seems to me that we are on the right track. I am sure that within another year or two some interesting things are going to be reported.

INFECTIONS IN WILDLIFE WITH THE VIRUSES OF VESICULAR STOMATITIS AND EASTERN EQUINE ENCEPHALOMYELITIS

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The majority of disease conditions observed in wildlife are mild and only rarely of such severity as to produce extreme illness or death. Death, when it does occur, is often the result of a multiplicity of disease factors, so that it is difficult to lay the blame on any one etiological agent. An extremely high frequency of infections in wildlife is produced by the viruses of vesicular stomatitis and eastern equine encephalomyelitis, yet the presence of these infections is generally unnoticed. The mild infection in wild animals may be the result of a long association between the host and the parasite. This is suggested by the severe illness or death that is not uncommon in man and his domestic animals, species that have been exposed to these diseases for only a few centuries.

The purpose of this paper is to describe certain infections in wildlife caused by the viruses of vesicular stomatitis and eastern equine encephalomyelitis and to illustrate some of the approaches which have been used in their study. To some individuals, who are familiar with these two viruses, it may seem inappropriate to consider them together, since their disease manifestations are quite dissimilar. On the other hand, their epizootiological behavior has so many points of similarity that it is advantageous to study them together.

In his historical review Hanson (1952) cites evidence that vesicular stomatitis of domestic animals has been observed in the United States for over one hundred years. The two serotypes of vesicular stomatitis virus, designated Indiana and New Jersey, were isolated in these states in 1925 and 1926. It was established that both serotypes of the virus caused vesicular lesions in and around the mouths and sometimes on the feet and teats of both cattle and horses.

Not until 1943 was it found that vesicular stomatitis may occur naturally in swine (as opposed to experimental infection) and by 1954 (Mikel, 1954) it was learned that enzootic vesicular stomatitis occurs in swine in the southeastern Atlantic Coastal Plain. This posed a grave problem for those responsible for the eradication and control of two other vesicular diseases of livestock, vesicular exanthema and foot-and-mouth disease, which are indistinguishable from vesicular stomatitis on clinical examination.

In 1950 (Hanson, *et al.*, 1950) the first confirmed cases of human infection with the virus of vesicular stomatitis occurred among laboratory personnel at the Wisconsin experiment station. The human disease has been described as influenza-like. Fever, chills, headache, myalgia and general malaise are the characteristic symptoms.

Although infections in domestic animals have been reported from time to time in many parts of North America, it was only in the Southeast that the disease was seen in enzootic proportions. Its seasonal occurrence and pattern of spread suggested transmission by some dipterous insect. The mechanism by which the virus is perpetuated throughout the winter in the absence of recognizable disease in livestock was not understood. Because of this, the presence of reservoir hosts for the virus among wildlife was postulated.

Although epizootics of encephalitis in horses were observed in the Eastern States many years previously, it was not until 1933 that the virus of eastern equine encephalomyelitis was isolated from infected horses in Virginia (Giltner and Shahan, 1933). Since that time the disease has reappeared each summer in certain areas along the eastern seaboard, and at longer intervals in other eastern states. A single isolation of the virus was made in Wisconsin in 1952 (Hanson, *et al.*, 1952).

In 1933 Giltner and Shahan reported on the pathogenicity of eastern encephalomyelitis virus for domestic pigeons. Since that time a number of investigators have demonstrated the capacity of the virus to infect a wide variety of birds (Davis, 1940; Kissling *et al.*, 1954). The virus has been recovered from natural infections in several species of wild birds (Fothergill and Dingle, 1938; Kissling *et al.,* 1951, 1955; Tyzzer *et al.,* 1938) and infections in others have been demonstrated by serology (Kissling *et al.,* 1955). The seasonal occurrence and spread of the disease which has coincided with periods of mosquito abundance soon led investigators to suspect arthropod transmission of the virus. In 1934 Merrill and co-workers demonstrated the ability of mosquitoes of the genus *Aedes* to effect virus transmission. Since that time a number of mosquitoes have been shown experimentally to be capable of transmitting the virus from diseased to susceptible animals (Davis, 1940; Chamberlain et al., 1954). In addition, isolations of virus have been made from a number of species of mosquitoes trapped in the wild (Chamberlain *et al.,* 1951; Holden *et al.,* 1954; Howitt, *et al.,* 1949).

In 1955, when the present study on vesicular stomatitis in the southeastern states was proposed, it was felt that the nature of the investigations was such that useful information on the epizootiology of equine ecephalomyelitis might also be obtained. Accordingly, it was decided to utilize whenever possible the specimens collected for serology and viral isolation for studies on both diseases.

STUDIES ON VESICULAR STOMATITIS

The methods and approaches used in these studies will first be outlined in general terms, followed by a more detailed discussion of the field and laboratory observations which were made.

The investigation, with respect to vesicular stomatitis, had several aims, enumerated below. Similar information was sought for the virus of eastern equine encephalomyelitis.

1. To determine the prevalence, host range, and geographic distribution of the disease.
2. To determine the means by which the disease is spread.
3. To detect the reservoir host for the virus, if such exists.
4. To explore possible means of control or eradication of the infection.

When suitable tests are available, a serological survey is the most economical means of obtaining information about the distribution of disease and the populations at risk. For this reason the serological sampling of a wide variety of animal species was the first step in the study. This facilitated recognition of domestic and wild animal hosts and established the frequency of infection in these species. In the same way, geographic delimitation of the enzootic area was started.

The next step was the laboratory study of infection in animals newly recognized as hosts by means of serology. Experimental infections were established to provide data on effective routes of exposure, incubation periods, signs of disease, duration of infection and excretion of virus. With this information in hand, the investigation returned to the field. The ecological approach was now employed to study the relationships between the recognized viral hosts, both domestic and wild, in an attempt to understand the transmission mechanisms involved. Animals under suspicion of acting as virus reservoirs were examined by viral isolation procedures. The importanc of these hosts in the epizootiological scheme could then be evaluated.

It may be well, at this point, to describe the attributes which one would readily associate with a virus reservoir. To function effectively as a source of virus for the infection of other species, the animal should be capable of harboring virus for a long period of time, should be capable of shedding virus at least intermittently, and should have frequent contacts, direct or indirect, with susceptible animal species. Because this animal might be incapable of manifesting an immune response to infection, it must not be assumed that the reservoir host could be detected by means of serology.

Biting or blood-sucking arthropods were examined as potential vectors by means of virus isolation in embryonating hens' eggs. Viruses obtained in this way were identified by virus neutralization tests using specific antisera. Insects which this procedure indicated as potential vectors were to be further studied in the laboratory by experiments devised to test their ability to transmit. The information gained during this investigation may now be reported in brief.

As a result of these studies vesicular stomatitis is now recognized as a disease which has been present in certain livestock and wildlife populations for at least 50 years and probably for centuries. The serological survey detected antibodies in about 50 per cent of the domestic cattle and swine and in about 75 per cent of the feral swine, 60 per cent of the deer, 45 per cent of the raccoon, and 35 per cent of the bobcats on the lower coastal plain of Georgia (Karstad, *et al.*, 1956). This is recognized as part of the enzootic region which extends north through North Carolina and south into Florida. It is suspected that this area of enzooticity may extend westward along the Gulf Coast. Serology in Wisconsin and in other areas where vesicular stomatitis is seen only occasionally has not revealed the presence of specific antibodies in wildlife nor has it detected antibodies in domestic livestock other than animals directly involved in these occasional epizootics. A serological survey among humans living in the enzootic area of southern Georgia indicates the presence of specific antibodies in about 25 per cent of 200 residents selected at random. Similar surveys are planned for other areas.

Five male white-tailed deer one year of age were used in experimental infection studies to determine the nature of the disease in these hosts (Karstad and Hanson, 1957b). The animals were exposed to the New Jersey type vesicular stomatitis virus by intradermal inoculation on the tongue, muzzle or coronary band of the foot. Observations made on body temperature, appearance of lesions, and immune response revealed that the deer were extremely susceptible to the infection, only 1/1000 as much virus being required to produce a tongue vesicle in deer as in cattle, with the strain of virus used in the study. One animal experienced clinically inapparent infection, evidenced by the development of a high level of virus neutralizing antibodies following the introduction of a small virus inoculum. In deer developing lesions, tongue vesicles were small, flat, and dry in comparison with those commonly seen in cattle. The surface epithelium of these lesions remained intact for a relatively long period of time. Sloughing of this epithelium on the second or third day after development of the vesicle was followed by rapid healing. During the time vesicles were present, animals salivated profusely and ate with difficulty. Stained tissue preparations made at this time revealed that particles of plant material became embedded in the degenerating epithelium. Recovery was usually complete within two weeks of inoculation.

Intradermal inoculation produced small vesicles on the muzzle which healed without complication. Macroscopic lesions were not produced by inoculation of the coronary band. This was surprising since reports have been received from the field of lameness in deer thought to be suffering from vesicular stomatitis. However, foot lesions are sometimes difficult to produce experimentally in cattle, yet they do occur in natural infection.

On the basis of these observations, it is felt that vesicular stomatitis in deer may be important only insofar as it interferes temporarily with their feeding activities. Under certain conditions where stresses, such as poor nutrition or parasitism, are superimposed, death losses may result. In the autumn of 1955 a report was received from Captain Chapman, Post Veterinarian, Fort Stewart, Georgia, of two deer in that vicinity, showing mouth and foot lesions, which had been caught and killed by dogs.

Similar infection experiments with raccoon indicate that these animals also are very susceptible, but that in almost every case clinically inapparent infections occur. The disease is of no recognizable importance to a raccoon population. Experimental infections in bobcats have not been studied. Domestic cats were reported by Wagener (1931) to be refractory to infection with vesicular stomatitis virus. Attempts to recover virus from experimentally infected deer and raccoon failed except in the very early stages of the disease. This, plus the fact that the animals experienced a prompt immune response, seems to rule out the possibility of their acting as virus reservoirs.

Finding that raccoon and swine can be infected by ingestion of vesicular stomatitis virus, it seemed that some of the lower forms of life which are found in their diet might serve as sources of virus. Therefore, viral isolation was attempted from a variety of cold-blooded species. These efforts to date have been unproductive. Experimentally, viable vesicular stomatitis virus was recovered from the lungs of cutaneously inoculated leopard frogs (*Rana pipiens*) up to six weeks following exposure. In searching for vectors or reservoirs of vesicular stomatitis virus, a great number of parasitic arthropods and helminths have been examined by viral isolation procedures, all with negative results.

STUDIES ON EASTERN EQUINE ENCEPHALOMYELITIS

Our studies on the epizootiology of eastern equine encephalomyelitis have served to supplement the work of other groups of investigators and have contributed to a fuller understanding of the natural host range of the virus, its geographic distribution and the biting diptera which may act as its vectors. A number of additional species of wild birds have been shown by means of serology to be susceptible to natural infection (Karstad *et al.*, 1957c). In addition to man and the horse, two other groups of mammals have been found to be naturally infected. Ten of thirty-eight feral swine examined in southern Georgia in 1957 carried serum neutralizing antibody titers against eastern encephalomyelitis virus. In the same areas three of 19 freetail bats, *Tadarida cynocephala,* carried significant levels of virus neutralizing antibody. The sera of one red bat, *Lasiurus cinereus,* and a small greyish bat of undetermined species also yielded antibody titers.

An experiment was conducted to determine effective routes of viral exposure in swine and to observe the signs of disease which might be produced by an eastern equine encephalomyelitis virus infection. The virus strain used in this and subsequent experimental infections was isolated from a horse brain in Georgia in 1956 and was maintained in the laboratory by serial passage in chicken embryos. All routes of exposure tried, nasal instillation, intravenous inoculation, and intradermal inoculation, were judged effective in that a prompt immune response was noted with the development of high levels of virus neutralizing antibody. Signs of disease were not observed. One of three contact pigs also developed an antibody titer.

Among birds giving serological evidence of eastern equine encephalomyelitis virus infection, the common crow has shown a very high frequency of antibody titers (Karstad *et al.,* 1957c; Kissling *et al.,* 1955). For this reason, an experiment was set up to determine the effective routes of exposure and the nature of the disease experienced by these birds. Adult crows, *Corvus brachyrhynchos,* were inoculated intracerebrally, intracardially and subcutaneously with 100 to 500 chicken embryo lethal doses of virus. Others were allowed to eat infected chicken embryos. Only the birds exposed by intracerebral inoculation and those fed infective material in large quantities developed significant levels of virus neutralizing antibody. Except for a questionable transient depression, signs of disease were absent. Limited attempts to recover the virus from blood on the second and fourth days and from tissues at 14 days after exposure were unsuccessful. Eastern equine encephalomyelitis virus in minute amounts was recovered at one and at four days post-exposure respectively, from the feces of two of three crows allowed to eat infected embryos. Histopathological changes characteristic of infection with the virus of eastern equine encephalomyelitis were present in the brains of the intracerebrally inoculated birds at 14 days post-exposure. Gliosis and perivcascular infiltration with leukocytes were the most pronounced changes. Intracardial and subcutaneous inoculations did not produce infection.

Similar experiments were conducted using weanling mourning doves (*Zenaidura macroura*). Birds were exposed by subcutaneous, intracardial and intracerebral inoculation and by oral instillation of approximately 10,000 chicken embryo lethal doses of virus. Immune response was noted in all except the birds given virus by oral instillation and one of the birds inoculated subcutaneously. It is of interest that this subcutaneously inoculated bird was the only one in the experiment which yielded virus from an emulsion of lung, liver and spleen when the birds were killed on the 14th day after exposure. Virus was recovered from the blood of one of the intracerebrally inoculated doves at 48 hours postinoculation. Histopathological changes characteristic of eastern equine encephalomyelitis virus infections were observed in the brains of all except the orally exposed doves. Signs of the disease were observed in only one case. One of the intracerebrally inoculated doves showed tremors, uneasiness, and jerky movements of the head and neck from the 44th to the 96th hour post-inoculation. Thereafter, the bird continued to hold the head tilted to one side until it was killed on the 14th day following inoculation.

A great horned owl, *Bubo virginianus,* was given one million chicken embryo lethal doses of eastern equine encephalomyelitis virus by intracardial injection. Two days later the bird appeared depressed and remained so for an additional two days. When killed on the 14th day following virus exposure, lesions characteristic of eastern equine encephalitis were evident on microscopic examination of the brain. Eastern equine encephalomyelitis virus was recovered from cerebral tissues in spite of the fact that a high level of virus neutralizing antibody was present in the general circulation.

A red-tailed hawk (*Buteo jamaicensis*) and a rough-legged hawk (*Buteo lagopus s. johannis*) were similarly exposed. Infection was produced in the red-tailed hawk as evidenced by antibody production. Neither bird showed signs of disease. Although histological evidence of encephalitis was present in the brain of the red-tailed hawk when it was killed 14 days after exposure, virus was not recovered from the tissues.

During the summer of 1956 three isolations of eastern equine encephalomyelitis virus were made from diptera collected in Georgia on premises where horses were affected with encephalitis. These comprised two species of mosquitos (*Aedes mitchellae* and *Anopheles crucians*) and one group of *Culicoides* gnats (species unknown) (Karstad, *et al.,* 1957a). Since no effort had been made in these tests to segregate insects freshly engorged with blood from the unengorged specimens, it is presumed that the virus isolated may have been present in undigested blood meals which these insects had obtained.

Discussion and Conclusions

The results of these studies have contributed in a small way toward a better understanding of the transmission, host range and pathogenesis of these two viral infections. Some progress has been made in evaluating the importance of these diseases to the wildlife species involved.

With respect to vesicular stomatitis, it is not known how the disease is perpetuated during the colder months of the year, whether arthropod transmission occurs (as is suspected), what significance there is in the disease in man, and how extensive is the wild animal host range. It seems that, under favorable environmental conditions, vesicular stomatitis does not constitute a grave threat to the wild animals that are at present recognized as hosts for this virus. However, under unfavorable conditions and in concert with other parasites it may overwhelm the normal defenses of the host.

The mechanisms by which eastern equine encephalomyelitis virus is perpetuated in nature have not been determined. Infections studied have been short-term in character, followed by death or by immunity in the convalescent host. Most workers agree that the horse is not an important part of the epizootiological scheme, since the viremia experienced during infection is insufficient to infect most of the potential vectors studied (Chamberlain *et al.*, 1954). The sum of available knowledge seems to indicate an arthropod-bird cycle of infection, with man and the horse entering in as accidental hosts. Chronic infection in some unrecognized animal host or persistence of virus in over-wintering mosquitoes may make it possible for the virus to survive during inter-epizootic periods.

The findings of virus-neutralizing antibodies in bats and in feral swine in enzootic areas indicate a need for investigation of these animals as potential sources of virus. LaMotte (1958) has reported the prolongation of Japanese B encephalitis virus infections in bats under conditions of hibernation. He was able to set up experimental bat-mosquito-bird infection cycles. Hulse and Edwards (1937) demonstrated extended periods of infection in hibernating hedgehogs with the virus of foot-and-mouth disease. Both workers reported a "re-awakening" of the infection when body temperatures returned to normal at the end of hibernation. Bellamy and co-workers (1958) report that eastern and western equine encephalitis virus infections in mosquitoes have been extended by induced hibernation. The effects of reduced temperatures in facilitating virus survival may eventually account for the annual summer recurrence of certain diseases in enzootic areas.

Natural infections in swine with the viruses of western equine, St. Louis and Japanese B encephalitis have been reported (Bang *et al.*, 1942; Burroughs *et al.*, 1954; Eklund, 1946; McNutt and Packer, 1943; Hammon *et al.*, 1942; Pond *et al.*, 1958).

In recent studies on eastern equine encephalomyelitis in wild birds, Satriano and co-workers (1958) report the recovery of the virus from feces of intraperitoneally inoculated pheasants. This corresponds to some extent with our recoveries of eastern equine encephalomyelitis virus from crows allowed to eat infected chicken embryos. The food habits of crows are such that virus could be acquired through the ingestion of infected tissues of other birds or mammals. The above-mentioned authors (Satriano *et al.*, 1958) also report experimentally induced infections in crows, great horned owls and a hawk. Their findings are in general agreement with ours.

The importance of eastern equine encephalomyelitis virus infections in wildlife is difficult to assess. The known host range is broad, and new host species are continually being recognized. The disease produced by experimental inoculation of wild birds is often of a mild or clinically inapparent nature. The disease is of grave significance to pheasant raisers, chiefly in the eastern states, where it is believed that "feather-picking" among the housed birds serves to spread the infection after it once gains entry to a flock (Jungherr *et al.*, 1958).

The principal arthropod vectors of eastern equine encephalomyelitis virus remain obscure. *Culiseta melanura* is the mosquito from which most viral isolations have been made (Chamberlain *et al.*, 1951; Holden *et al.*, 1953; Howitt *et al.*, 1949). It is believed to feed only on avian hosts. Unfortunately, this species does not readily lend itself to laboratory colonization, so that it has been difficult to test experimentally its ability to transmit virus (Chamberlain *et al.*, 1955).

In the study of these two diseases we have learned to exercise caution in incriminating wild animals as reservoirs of infection. The wild animal hosts for these viruses that have been studied appear to be as dependent upon other unknown sources for infection as are man and his domestic animals. It is felt that in the past, errors made might on occasion have been avoided had a more thorough study of the situation been made before concluding that wild animals perpetuated livestock or human disease.

In conducting these studies we have been impressed by the willingness of all state and federal governmental agencies to cooperate when the need for aid is adequately outlined. It is our opinion that opportunities for joint research should be embraced rather than avoided. It should be obvious that studies on the zoonoses, to be successful, would require the combined efforts of individuals in the fields of public health, agriculture and wildlife conservation.

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DISCUSSION

DISCUSSION LEADER DYKSTRA: I could not help but be impressed by the different problem that is represented by the presentation by Dr. Karstad as compared to the earlier paper, which dealt primarily with diseases and mortality producing factors in wildlife. This paper impressed upon me the fact that some of the ailments of mankind aren't always due to some of the wild creatures that superficially appear to be the prime carriers. Nevertheless, they are important and it is certainly encouraging to know of the work going on in this field.

DR. FERRIS: Can you tell us more of the vitality of the virus in bats?

DR. KARSTAD: I don't have any information from my own work. I have been citing the work of LaMotte, who has induced hibernation in these animals soon after infection, and the virus was able to persist for as long as 107 days of hibernation. When these animals were removed from hibernation, the virus was not immediately present in the blood but, after three days, it returned.

DR. FERRIS: Has he published all of that information yet?

DR. KARSTAD: Yes, you will find his paper in one of the 1958 numbers of the *American Journal of Hygiene.*

DR. HERMAN [U. S. Fish and Wildlife Service]: In work that has been done on encephalitis of birds, horses and man in the western states, they have demonstrated that bird-to-bird transmission can go by way of mites.

DR. KARSTAD: I myself have not done any work with mites but some work was done at the University of Wisconsin before I came into the picture. It seemed to indicate that mites may transmit virus at least from bird to bird but apparently merely as mechanical vectors and biological transmission has never been shown. In other words, the multiplication of the virus within the mite has not been detected.

I am not prepared to even guess as to what the important vector of disease transmission from birds to mammals may be in the areas that I have worked.

MR. JOHN STEEL [Tacoma]: I am interested in the viewpoint you might have on the sparrow, the starling or the pigeon in relation to any diseases that could be given to farm animals. Is there anything in your studies on that?

DR. KARSTAD: No. I am afraid that you have given me quite a task there. The only thing that I can say is that, from our experience, there is no use in jumping to conclusions, and, regardless of what the picture may seem on the surface, one has to gather whatever information is possible from the field, from natural outbreaks. Then you have to take the problem into the laboratory and try to set up experimental infections with these species and try to determine if they are important and can serve as hosts for organisms, can perpetuate infection for any extended period of time, or can serve as important spreaders of infection to domestic stock. I think that there is a great tendency to incriminate wildlife as important sources of infection. However, I think that it may often work the other way.

ASPERGILLOSIS IN WATERFOWL[1]

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Waterfowl, just as man and other animals, are subject to a wide variety of disease conditions. Some diseases such as botulism, which produces a high mortality in localized areas, have been studied extensively for a long time and, as a result, have come to the attention of many biologists and sportsmen. Other diseases, because their occurrence is less dramatic or because they have received less study, are not widely known or understood even though, in the aggregate, they may be of great significance. One such disease in waterfowl is known as aspergillosis.

This disease primarily affects the respiratory system which in birds is unlike the mammalian system. Connected with the lungs are several pairs of airsacs within the body cavities. In many species, particularly in large flying birds, extensive air cavities within the bones open into the airsacs. The main function of the airsacs apparently is to act as bellows for moving air over the respiratory surfaces of the lungs.

Aspergillosis is a disease caused by a number of species of a fungus, *Aspergillus,* which cause lesions most frequently in the airsacs and lungs of a variety of birds. By far the commonest species is *A. fumigatus.* It is the chief cause of death in captive penguins in zoological gardens and is observed frequently in many other species of birds. It occurs rarely in mammals with very occasional fatal cases in man. It is of frequent occurrence in wild as well as captive waterfowl and several severe outbreaks have been reported in North America involving ducks (Herman, 1943; Bellrose, *et al.,* 1945; Neff, 1955), geese (Christensen, 1932), and swans. Veterinary text books, referring to this disease in poultry flocks, point out that the source of infection is usually moldy feed or litter. In a natural outbreak, aspergillosis killed 11 of 50 Canada goose goslings 3-6 weeks old which were being used for experimental purposes at the Patuxent Research Refuge several years ago. Check of feed and litter by culture on Sabouraud's dextrose agar medium failed to reveal the source of this outbreak.

[1]The presentation of this paper at the Conference was illustrated by a film "Aspergillosis, a fungus infection of the respiratory system of waterfowl," 16 mm, color, silent, 15 minutes. Produced by Rex Gary Schmidt, Chief, Section of Visual Information, Office of Information, U.S. Fish and Wildlife Service, College Park, Md. Photography by Rex Schmidt and W. J. L. Sladen.

During the past year we have conducted studies at the Patuxent Research Refuge and at the Johns Hopkins School of Hygiene and Public Health in an effort to uncover facts relating to this disease in waterfowl. Field studies were conducted primarily in the Kent Island area of the Eastern Shore of Maryland, where losses among whistling swans and Canada geese have been recurrent in the past. We are attempting in the present paper to point out some of the problems and techniques involved in these studies. We thus hope to stimulate further interest and research on this important disease of waterfowl and other birds.

Studies on the causative agent of this disease have indicated that spores of *Aspergillus* occur widely in soil, in decaying organic material and as an air contaminant. Since both Canada geese and whistling swans on the Eastern Shore of Maryland (where losses from aspergillosis in these birds have been observed) are known to feed extensively in corn fields, we conducted studies in this habitat and isolated *Aspergillus* in cultures from soil samples and from various plants. It was most readily collected from corn stalks, cobs, and other plants in winter and spring. The corn cobs frequently exhibited decaying greenish areas of fungal growth. In the drier conditions, poking these areas with a probe caused the release of a powdery green dust composed of fungal spores. By planting this material on an agar base medium in a test tube we frequently were able to obtain a concentrated growth of *Aspergillus*. Material grown on these cultures was later inoculated into chickens and ducklings and caused a fatal disease with the characteristic pathological picture seen in natural outbreaks of this disease. The fungus was then re-isolated from the birds by culture technique. *Aspergillus fumigatus* was most frequently encountered.

In earlier experiments we infected Canada goose goslings and chickens by means of dust exposure to a strain of *A. fumigatus* originally isolated from a Canada goose. The experimental birds were confined in an airtight box and a cloud of the green spores was introduced so that the birds were forced to inhale them. Death resulted in every case. Since we were unable to develop a method of controlling doses by this method of exposure, we devised a technique for inoculating known numbers of spores directly into airsacs. By this procedure we were able to subject experimental birds to known numbers of spores and thus to determine the effects of varying exposures.

In most of our experimental studies we used a strain of *A. fumigatus* originally isolated from a penguin which died at the National Zoological Park, Washington, D. C. The *Aspergillus* was first grown on

Sabouraud's dextrose agar medium in special culture bottles which provide a large growing surface. The greatest growth of spores was produced when the cultures were incubated at 37°C. for 5-7 days. To harvest the *Aspergillus* spores the surface of the culture was covered with a sterile detergent (Alevaire) and either agitated or scraped with a sterile rod. Each sample was filtered through gauze and the number of spores per unit of diluent was determined by counting them in a hemocytometer under the microscope.

We used chickens, 1-5 weeks old, as our test animals because of their availability. Some experiments were conducted on domestic ducklings, adult mallards and Canada geese. Known numbers of spores were inoculated into one of the thoracic airsacs. From this procedure we determined that approximately one million spores suspended in ½ cc Alevaire killed less than half the young birds, 10 million spores killed over 80% and 50 million killed all inoculated chickens as well as ducklings. By inserting a tube through the mouth into the gizzard we force fed suspensions of as many as 200 million spores to chickens and ducklings. These birds showed no symptoms and no characteristic lesions were produced, further emphasizing the fact that the route of entry is the respiratory tract and that infection is not obtained from eating contaminated food.

Older chickens, 3 months to one year, and adult mallards and geese required much larger inoculations into the airsacs to produce the disease. The physical condition of the host appeared to be even more important than size of dose. Adult chickens and geese were able to survive weekly inoculations of as many as 500 million spores but when weakened by forced starvation or other causes they readily succumbed to much smaller doses.

Experimental birds often died within 2 days after inoculation. They showed extreme weakness and difficulty in breathing. Birds that survived as long as 11 days usually recovered. In such birds, when sacrificed three weeks after inoculation, it was difficult to find any significant lesions.

The findings at autopsy in experimentally inoculated birds generally were characteristic of lesions found in birds which died in nature from natural exposure. Whether the inoculation was by dust or by direct inoculation into the airsac seemed to have little effect on resultant pathology. There was extensive involvement of the thoracic airsacs, very infrequent involvement of other airsacs. The lesions in the airsacs varied from small pinpoint yellow spots to complete consolidation with a cheesy, spongy or solid mass of yellow material. The normally thin airsac walls frequently were greatly thickened. Usually both lungs also became involved. This varied from spotting with small yellow flecks, to the development of large yellow granules; to a condition of consolidation. In many cases a portion or all of the lung became obliterated with the same type of cheesy, spongy or solid mass seen in airsacs. Only infrequently, in these experimental infections, did we see development within airsacs or lungs of an area containing a green dust of the *Aspergillus* spores. This condition, however, is frequently seen in natural infections of waterfowl, gulls, and penguins, and it is conjectured that these lesions can cause the infected bird to exhale viable spores that could serve as a source of infection to other birds. Lesions were usually confined to the respiratory system but occasionally lesions were observed in the liver and less frequently in other tissues.

Death appeared to be caused by loss of function of lungs and airsacs from the overwhelming lesions. However, the great degree of variation in extent of lesions in fatal infections seems to indicate a probable toxemia as well.

While this disease might occur in wild birds at all seasons of the year, experimental studies seem to indicate a much greater susceptibility among the young. Thus the age group which is most susceptible to this, as well as many other diseases, is the group concerning which we have least information in nature and also the group which exhibits highest natural mortality. Much further study is needed here.

It perhaps is significant also that most outbreaks of aspergillosis in waterfowl that have come to our attention occurred in late winter or early spring during northward migration, complicated by shorter food supplies, freezing conditions and, in general, a weakened flock of birds. This seems to tie in with our experimental findings, for we readily killed weakened, emaciated adult geese with small inocula, while even doses of 500 million spores seemed not to faze healthy, plump birds.

We are continuing our studies of aspergillosis in waterfowl in an effort to determine better methods of diagnosis in living birds, source of infection and means of combatting this disease.

SUMMARY

Aspergillosis, a respiratory disease most commonly caused by the fungus *Aspergillus fumigatus,* although frequently the cause of losses in captive birds, has been little studied in wild waterfowl and other avian species. Evidence indicates this to be of importance in the wild, and studies were conducted to determine factors relating to its epizoology. Field collections from corn and other plants have yielded

infective spores of *Aspergillus* which were inoculated into experimental chickens and ducklings and then re-isolated from characteristic lesions. A technique was developed for inoculating suspensions of known numbers of spores directly into one of the posterior thoracic airsacs. It was demonstrated that less than one million spores of *A. fumigatus* killed less than one-half of the experimental chickens, 10 million spores killed over 80 per cent and 50 million killed all inoculated chickens as well as ducklings. Older birds were able to survive as many as 500 million spores except when in a weakened condition. Chickens usually started dying within two days after inoculation while those that survived as long as 11 days usually fully recovered by three weeks. Pathological involvement usually was confined to lungs and airsacs. The procedures and techniques involved in these studies were illustrated on a color motion picture.

ACKNOWLEDGMENTS

We are grateful to Rex Gary Schmidt, U. S. Fish and Wildlife Service, for producing the film; and to the following for advice and help: Dr. C. W. Emmons, National Institutes of Health; Dr. T. R. Reed, National Zoological Park; Brenda K. Sladen, Johns Hopkins University School of Hygiene and Public Health; and J. O. Knisley, Jr., Patuxent Research Refuge; and to the New York Zoological Society for some financial help to one of us (W.J.L.S.).

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TECHNICAL SESSIONS

Monday Afternoon—March 3

Chairman: James T. Shields
Fishery Biologist, Department of Game, Fish, and Parks, Platte, South Dakota

Discussion Leader: Peter I. Tack
Head, Department of Fisheries and Wildlife, Michigan State University, East Lansing, Michigan

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WETLANDS AND INLAND WATER RESOURCES

THE TIME OF FORMATION OF PAIRS IN BLACK DUCKS[1]

Vernon D. Stotts
Game and Inland Fish Commission, Baltimore, Maryland

The termination of waterfowl hunting seasons on wintering grounds has been determined, in part, by the dates that were believed to be coincidental with the greatest initiation of pairing activity. The purpose of this paper is to show that substantial numbers of black ducks (*Anas rubripes*) are paired throughout the year and that pairing in the early postbreeding season must be among adult birds.

Some investigators have indicated that many waterfowl species begin to pair in late summer and early autumn. Hochbaum (1944) observed males of several species in extra-seasonal courtship displays while in postnuptial plumage in late summer. He noted true courtship activity in male and female mallards (*Anas platyrhynchos*) in late autumn. Trautman (1947, 1949) and Wright (1954) noted or collected juvenile and adult black ducks which either appeared paired or were in courtship display in late August and September. Singleton (1953) noted pairs among mottled ducks (*Anas fulvigula maculosa*)

[1]This study was conducted under Maryland Pittman-Robertson Project W-30-R with the field assistance of R. N. Smith of the University of Maine and C. L. Hanson of the Ohio State University. Special thanks go to D. E. Davis of the Johns Hopkins University for editing the manuscript.

throughout the year, and during August inventories, four per cent of these ducks were paired.

The study area was a tidal zone directly east of Annapolis, Maryland, on the eastern shore of the Chesapeake Bay. One of the largest populations of breeding black ducks on the mid-Atlantic seaboard is found here. The area is populated primarily by resident birds from late March to late September. Returns from banded residents indicate very little movement south or west, but there is considerable northward movement in early autumn by all sex and age classes. A substantial number of both adult and immature males migrate to northern breeding grounds in the spring.

METHODS OF STUDY

Counts of black ducks, made from a boat during normal banding and nesting studies, noted whether birds were seen in pair-like doubles, as singles, or in flocks. Flocks were always flushed and watched until out of sight. Pairs or doubles within a flock were distinguished by their appearance of unity within the flock structure. These doubles always flew in close formation whereas unpaired birds flew haphazardly without any visible leadership or group bond. Since some of these doubles may not have been truly paired birds, let it be understood that the terms "pairs" or "doubles" are interchangeable in this paper.

The following classes of birds observed were excluded from the present data: (1) flocks of more than 100 birds which were common from early September to mid-March, since accurate counts and species differentiation became difficult, (2) females on nests, (3) females with broods, and (4) flightless young. Omission of females on nests was of no consequence since they either had attending single males which were counted as pairs or, as in the case of brooding females or flightless young, they were incapable of being paired at the time of observation.

Additional observations were made on trapped adults to determine their status in the annual cycle by plumage characters. Maturation development data was also taken on trapped juveniles. It was possible to relate some of these data to pairing activity.

Some paired birds were collected in November after they had shown favorable signs of being paired in order to determine their ages.

RESULTS

Counts of black ducks were made from early February to early November in 1956 and 1957 (Table 1). Samples within any four-week period ranged from 176 to 9,099 birds. The greatest number of observations in diversified habitats was made from mid-June to late October during daily operation of banding traps over a 15- to 30-mile route.

TABLE 1. NUMBERS OF BLACK DUCKS SEEN DURING SHORELINE SURVEYS BY BOAT IN 1956 AND 1957[1]

Four-Week Period	Number In Doubles	Number In Singles	Number In Flocks	Total Number	Per cent In Doubles[2]
Feb. 11—Mar. 10	88	0	88	176	50.0
Mar. 11—Apr. 7	330	18	246	594	58.6
Apr. 8—May 5	832	263	152	1,247	87.8
May 6—June 2	672	281	216	1,169	73.5
June 3—June 30	370	206	1,753	2,329	18.8
July 1—July 28	126	193	1,965	2,284	5.5
July 29—Aug. 25	194	247	6,072	6,513	3.0
Aug. 26—Sept. 22	506	238	8,355	9,099	5.6
Sept. 23—Oct. 20	914	156	7,726	8,796	10.4
Oct. 21—Nov. 17	116	13	639	768	15.1

[1]The following classes were not included: ducks in banding traps, ducks in flocks larger than 100 birds, females on nests, females with broods, and flightless young.
[2]Singles were considered to be wholly paired March 11-May 5, two-thirds paired May 6-June 2, one-third paired June 3-June 30, and not paired before and after these periods.

From February 11 to March 10, when some black duck nesting had begun, paired birds made up to 50.0 per cent of total counts. As nesting activity reached its peak in the April 8 to May 5 period, pairs were at their height with 87.8 per cent of the populations paired. By the July 1 to 28 period, when the last nests were begun, pair counts fell to 5.5 per cent.

The lowest level of birds seen as pair-like doubles was found from July 29 to August 25—3.0 per cent. There was some increase during the next four weeks, and then once again doubles became very evident.

At this time the population was 26.3 per cent adult during both years. If the early-paired birds were wholly adult, the percentage of adult birds paired in the whole population can be estimated by a multiplication factor of 3.8. For instance, at the low point in the curve of birds seen in pairs, 8.4 per cent of the adult population was paired.

By the October 21 to November 17 period, 15.1 per cent of the populations were in pairs. Cursory observations indicated that a large portion of the December and January populations were in pairs but no data was collected.

If only one of a pair of ducks was caught in a banding trap, the other duck usually stayed near the trap and was reluctant to flush upon approach by the observer. Such incidents became common among black ducks in September.

During summer and autumn banding operations, both adult and immature black ducks were examined to determine if physical signs might indicate whether they were paired or capable of being paired. For instance, most adult black ducks were examined to see if they had passed through the flightless stage. During 1956 and 1957, respectively, 325 adults with an even sex ratio and 466 adults with a ratio of 110 males to 100 females were sampled. Half the males had assumed postnuptial or autumn plumage by the last half of July. By September 1, all adult males had passed through the flightless stage. These stages in the adult female molting cycle were reached about September 1 and late October, respectively. However, during the two years, some individuals of both sexes were found in postnuptial plumage by the third week in July when some of the population was still active in nesting duties.

When juvenile black ducks were examined, it was found that females attained certain adult characters before the counterparts in males. For instance, the female's voice matured and her bill took on the adult spotted appearance before she began to fly. The male's voice did not mature until a month or more after flight began. His bill usually did not become wholly adult until nearly five months later. Combining the sexes, 50 per cent of the immature birds in a sample of 615 assumed nuptial plumage by the last quarter of September. During the last week of banding operations (October 18 to 24) somewhat over 80 per cent of the immature birds were in nuptial plumage with regard to tail, belly, and breast feathers.

In addition, the penis of the immature male may show evident signs of maturation at about five months of age, but penis maturation did not begin until after the postjuvenal molt had renewed at least the breast, belly, and tail feathers. In a sample of 413 males, 50 per cent had visible signs of penis maturation by the third week in October but less than five per cent had developed to a point considered to be 50 per cent mature. The penis in most immature males probably does not become completely mature until the bird is eight or more months old—or about January or February.

Thirteen individuals from ten black duck pairs were collected in November, 1957 (Table 2). Autopsy of three pairs collected showed all six birds to be adult. Five had been banded and of these, four were resident breeding birds in 1957. The age composition of the other

TABLE 2. AGE COMPOSITION OF BLACK DUCK PAIRS COLLECTED FROM NOVEMBER 1-30, 1957

Age	Sex	
	Male	Female
Immature	0	1
Adult	7	5
Unknown	3	4

seven birds collected on later dates, none of which were collected together as a pair, was adult except for one female shot on November 22.

DISCUSSION AND SUMMARY

In renumeration, consider these points: (1) the lowest level of paired birds seen was during early August when (2) all mating bonds among the season's breeding pairs had been broken and when (3) all males and about 50 per cent of the females had completed the postnuptial molt and when (4) the very oldest immature birds were about three to four months old and were considered too immature to have completed a pairing bond. At that time and for some time in the future, it is believed that birds in pairs were adults in postnuptial or autumn plumage.

Beginning in August, pairs gradually increased through January with, perhaps, many plateaus or setbacks by gunning pressures. In February, pairing activity increased with the result that pairs were at a peak of about 90 per cent of the population as breeding began. A gradual decline followed through the breeding season with a slump once again in July and August.

Collections and observations of physical characters indicated that immature black duck females probably began to pair before immature males. The first immature female was collected after mid-November when her minimum age would have been between three and four months and her maximum age about seven months. No immature males were collected but the overall sample of paired birds was small.

A high percentage of adult birds are paired by the time of some hunting seasons. Thus, many of these adult pairs, which would be the more efficient nesters the following year, would be broken up by hunting pressures.

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DISCUSSION

MR. ROBERT D. CURTIS [Michigan Department of Conservation, Munith, Michigan]: I would like to ask the speaker how he distinguishes the pairs in a flock of up to a hundred black duck in the fall?

MR. STOTTS: As a normal rule, there were two of us checking, and we took flocks of no more than one hundred birds. We first made our count and then, using binoculars, watched them for as much as a half a mile or more. The pairs had an appearance of unity and stayed together, whereas the unpaired birds tended to scatter in all directions.

MR. CURTIS: I noted the same situation in Michigan, and on many occasions pairs and doubles would land in an area where I could note bill characteristics. Some times I found them to be two females or two males. Would you consider them pairs or just doubles?

MR. STOTTS: I would consider them doubles. There are many instances where some of the birds would not be pairs. But I had to include them because there was a possibility that they were pairs.

MR. CURTIS: Have you drawn any conclusions on pairing throughout the year, whether approximately ten per cent of blacks would be paired throughout the year?

MR. STOTTS: No, I would not. They would drop lower than that at about the time they were in the flightless stage.

MR. CURTIS: At that time there are no pairs whatsoever?

MR. STOTTS: No, I would say there is an overlap. Some of the birds that had either given up nesting or were through with their nesting, would have passed into a stage where they could once again be paired and there were some ducks that had not finished mating yet. Therefore, they were still paired. There would be an overlap between last year's birds and next year's birds.

BIOLOGY AND MANAGEMENT OF THE HAWAIIAN GOOSE

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The Hawaiian goose or Nene (*Branta sandwicensis*) is one of the rarest species of waterfowl in the world; even the Laysan teal (*Anas platyrhynchos laysanensis*) has been found to exceed it in numbers (Woodside, unpub.). A species endemic only to the Hawaiian Islands, its numbers are thought never to have exceeded 25,000 (Baldwin, 1945). We know that less than 100, and probably only 50, now remain in the wild.

The precarious state of this species was pointed out to management by the Schwartzes (1949) and by Smith (1952), who were then employed by the Hawaiian Board of Agriculture and Forestry. It is proper that this agency has spear-headed efforts to save the species from extinction. It is truly the obligation of management to study and help to preserve species too rare for immediate thoughts of harvest. This is especially true in the case of the Nene, for hunting must have contributed heavily to its decline. Ignorance of the winter breeding season of the Nene was responsible for open shooting seasons while females were incubating, followed by broods or were molting and flightless. This was first pointed out by Henshaw in 1902; he also was first to see the need for planning in order that the species be saved from ultimate extermination.

To learn whether modern management approaches could save the Nene, the Board of Agriculture and Forestry sponsored this study. Its objectives were essentially those of the present paper, namely (1) to learn the present status of the species in the wild, (2) to discover essential facts in the biology of the wild population, (3) to prepare practical management suggestions and (4) to appraise the efforts being made by the Board and the Wildfowl Trust in England to rear Nene in captivity.

The most pressing need was to learn how many Nene remained in the wild and where they nested. The search for the breeding ground of a vanishing species is fraught with a multitude of special difficulties as R. P. Allen has so well pointed out in his persistent efforts in studying the Whooping Crane. Paul Baldwin spent several years on the island of Hawaii and gathered much valuable informa-

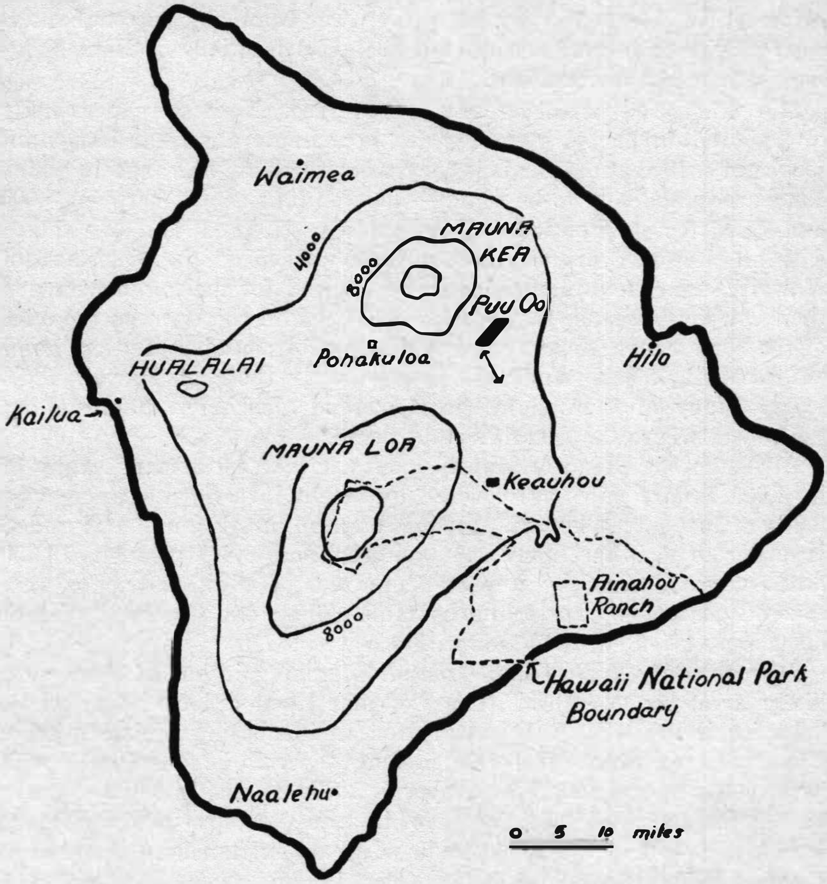

Figure 1. Map of the Island of Hawaii showing 4000-foot contour lines, principal towns, and location of the Nene rearing projects. The areas used by wild Nene are blacked in; the arrow indicates the summer flight line.

tion about the Nene (1945, 1947) but found no current evidence of breeding. The Schwartzes (1949) followed up all reports of Nene sightings during their two years in the islands but did not see birds in the wild.

THE NENE IN THE WILD

Despite continued newspaper publicity concerning the Nene project and the efforts of J. D. Smith to set up a public reporting system for observations of wild birds, only a handful of reports had come in since 1950. It was apparent that either the birds had declined alarmingly or that men who visit the remote Nene range do not volunteer information. Hence the present survey was begun by personal interview seeking first-hand accounts of the exact locations of Nene sightings both recent and ancient.

More than 150 persons likely to have seen Nene were personally interviewed during the year. Pig and goat hunters were an important source of information, for it is they who frequent the range in which Nene are most likely to be found—the mountain slopes between 5,000 and 7,000 feet as pointed out by Baldwin (1945, 1947). We talked with all the surveyors we know to have worked on the big island of Hawaii; sugar cane plantation managers and foremen; ranchers and their cowboys, because they spend much time in the open on the edge of the Nene range; forest rangers who patrol boundary fences; game enforcement officers; and old-timers—mostly those of Hawaiian descent. Many of their sightings converged amazingly, pointing out the places where the search should begin.

Although the island of Hawaii looks small on most maps, many of its 4,021 square miles are covered by recent lava flows, leaving vast fields of loose, treacherous, clinkery terrain, mostly on steep grades. In order to visit the likely spots where Nene had been seen, 18,000 miles were traversed by jeep and hundreds of additional miles were covered on foot, by horse and by mule. The soles of a good pair of boots were often cut to shreds within a week.

Discovery of the Breeding Ground. Searching in one of these most likely areas for the third time we came upon a lone Nene, whose behavior indicated it was waiting for an incubating female nearby. Thus, what we believe to be the first nest ever to be seen in the wild by a biologist, was found November 9, 1957. It was in a tiny *kipuka* (a vegetated area of but a few acres in a huge expanse of more recent bare lava flows) in the upper lands of Keauhou Ranch on the eastern slope of Mauna Loa at 6,500 feet (Fig. 1).

From this nest with two eggs, one young hatched on Thanksgiving day (Nov. 22, 1956). This gosling vanished the next day and a mongoose (*Herpestes auropunctatus*) was trapped 20 feet away. There was no sign of feral dog or pig in the kipuka. Thus ended the only Nene nest reported from the wild in the past 20 years. Intensive search in this kipuka revealed three old nests in progressive stages of deterioration, indicating that it had been sought out, probably by the same pair, for four successive years of nesting.

Subsequent field work in the area proved that it was the long-sought-after breeding ground of the remaining Nene flock. From November 9, when we discovered the nest, until May 21 when the birds were last seen in the area, we observed Nene here 31 times. At least six pairs used the area. Each family group was distinguished

TABLE 1. NENE FLOCKS OBSERVED IN THE WILD—SEPTEMBER 1956 THROUGH AUGUST 1957

Size and composition of flocks	6 Pair + 4 yng	5 Pair + 3 yng	4 Pair + 2 yng	4 Pair + 2 yng	3 Pair + 1 yng	3 Trio	2 Pair
Approximate date incubation began	Nov. 18	Dec. 1	Dec. 1			Oct. 23	
BREEDING GROUND at Keauhou Ranch	Jan. 6 Apr. 28	Jan. 5, 27,[1] 31 Feb. 6, 21, 27 Mar. 14 May 13	Jan. 5, 24[2] May 13	May 13, 21	Apr. 17, 28	Nov. 9, 13, 16, 19, 20, 22, 23 Dec. 3, 13 Jan. 6, 31 Apr. 17 May 21	May 21
SUMMERING GROUND Puu Oo Ranch (Night Roost)	July 2	July 14	July 10, 14	July 10, 14	July 10	July 10	July 2 Aug. 7, 10
Saddle Road (Flights)	July 7, 8, 9, 17, 20, 23 Aug. 10	July 7, 9, 17, 23 Aug. 10, 11	July 7, 9	July 7, 9	July 9, 17	July 7, 9, 23	July 3, 6, 9, 19, 21, 23 Aug. 10, 27

[1]One adult and three young color banded on this date.
[2]Two young color banded on this date.

by the number and age of the accompanying broods as shown in Table I. Identification of two of the families was made certain and permanent by the capture of one of the flightless adults and the three half-grown young of the family of five, and, on another occasion, the two young of the family of four. Each bird was marked with a permanent, colored, plexiglass band as devised by Balham and Elder (1953).

All observations of these groups were within 2½ miles of the nest kipuka. Usually the birds were found hiding quietly at the edge of a brushy or wooded area. Little or no calling was heard until the end of the flightless period. Their movements were further documented by continuous search for droppings—the freshness of these frequently led us to their hiding places.

Many days of search together or separately in this trackless, nearly treeless expanse were not rewarded by sight or sound of geese, yet we believe they did not wander far from these few square miles, for it was not until the end of the flightless period that we found droppings in nearby Three-Trees Kipuka in Hawaii National Park.

The Breeding Season. It is indeed surprising to find this species of waterfowl breeding on a declining day length, at quite the opposite season to that characteristic of the family Anatidae. First egg dates from clutches laid at the Pohakuloa project have extended from October 29 to February 8, and were almost evenly divided by the winter solstice—15 occurring before and 18 after December 21.

Close study of the plumage development of captive birds enabled us to judge the age of the wild broods observed and to back-date to their day of hatching. Date of nest inception was then computed by subtracting the 30 days required for incubation (based on 16 clutches observed at Pohakuloa, and Delacour, 1954:147). We thus determined that first egg dates in the wild this year extended from October 20 to about December 1.

Renesting. We saw no evidence that this occurred in the wild this year; the pair that lost its brood the day of hatching did not renest, as shown by our repeated observations of this trio in December, January, April and May (Table 1).

That renesting can be induced by taking first clutches from females laying in captivity has been abundantly shown at the Pohakuloa project where second clutches have been started from 13 to 43 days after the first clutch was removed. Some geese have thus been induced to lay three or even four clutches in one season.

Non-breeding Birds. Only one unpaired, non-nesting bird was seen in this area. It was attached to the pair whose nest was found. It waited in the vicinity and was once seen to join the pair when the goose left for her daily nest relief. It was seen in the company of this pair in the nest vicinity on many occasions as shown under "Trio" in Table I. That no other "unemployed" birds were found indicates that either there was very poor success in the previous year or that these birds go elsewhere during the breeding season.

We have but one observation during this season—October through April—to support the latter hypothesis. Forest Ranger Ernest Pung saw one Nene on the south slope of Mt. Hualalai at 6,000 feet on November 27. This spot is thirty miles to the northwest of the breeding ground on Mauna Loa. A three day intensive search was then made without finding birds or sign. But months later we found numerous scattered droppings 2 miles to the southeast near Ahuaumi's "temple." These were neither concentrated nor in the abundance characteristic of the nesting ground. We believe they indicate another family or two as yet unseen or the breeding season resort of the unemployed birds.

From these observations we conclude that in 1956-57 the Keauhou breeding ground on Mauna Loa had at least 6 adult pairs and one unemployed bird, and that 12 young were produced for an average production of 2 young per breeding pair. The additional pair without young was seen but once (Table I). They may have nested elsewhere and lost their brood.

The Rearing Season or Flightless Period. The duration of the flightless period is very great in the Nene because of the slow growth rate of the young. Detailed observation of captive birds showed that 10-12 weeks are required for young to grow to flying stage—as indicated by hardening of one half of the primaries (Weller, 1957) and by initiation of trial flights within the rearing pens. This is nearly twice the time required for young Canada geese to get on the wing (Dutcher, 1885; Bent, 1925:212). The slower growth of the Nene is undoubtedly associated with its tropical range — not only are there no long days as found in the sub-arctic rearing grounds of the Canada goose but the young are hatched in November, December, and January when days are even shorter than at other times of the year. Thus many fewer hours for feeding are available. In addition, there are many days when heavy fog or incessant rain sets in by two in the afternoon and continues throughout the night. This daily weather pattern is characteristic of this belt just above the tropical rain forest on the windward side of the mountains.

Observation of captive birds also showed that the adults are completely grounded by the wing molt and resulting flightless period for 4-6 weeks, as in other species of geese. That the family is not always in phase is shown by our observations of the brood with three young in the wild. One parent took to the air when the other was fully grounded with the young. It would be valuable to know whether this is always the case in the wild and whether some protection of the brood is assured in this manner. In any case, part or all of the Nene family is vulnerable to ground-running predators for three months or more each year.

Predators. Considering the great potential longevity of these birds and the fact that they lay fertile eggs in captivity for many years, the species should be able to build back its numbers if no catastrophe occurs (a single lava flow from Mauna Loa, the world's most active volcano, could wipe out nearly all the birds if it occurred during their flightless season). A more serious and continuous menace is from the introduced predators—cats, dogs, pigs, and mongooses, all of which are feral in the district. In no place on the island did we find more wild pig sign than in the National Park. Without any effective predators their numbers have built up seriously in the Park since hunting was abolished there a few years ago. Controlled hunting is badly needed to reduce their numbers.

Flocking and Summer Flights. Whereas each family had remained isolated and was seldom seen with other birds from October through April, flocking started soon thereafter. On May 13, 1957 the two families of four were found together for the first time. Although they kept several yards apart when on the ground (one included the two color-banded young) they came and went as one flock.

The last flocks were heard flying over the breeding ground June 5. The last fresh droppings were found there June 15. We conclude that after the rearing season flocking and considerable wandering occurs for about one month before the birds move to their regular summering ground. This period seems to be the equivalent of the fall migratory period in continental waterfowl.

The Summering Ground. In 1955 Forest Ranger Ah San discovered a flock of eight Nene near the forest boundary in Herbert Shipman's Puu Oo Ranch (Wildfowl Trust, 7th Ann. Rep.). The junior author followed up on this report with many observations (Woodside, 1956) and determined that the birds made a twice daily flight across the Saddle Road—the only road crossing the island. He followed these flights across jungle and lava and determined that their line of flight in the evening was northwest to the Shipman ranch where they feed and roost for the night. In the morning they flew back in the opposite direction over the road to isolated lava flows for the day. All-day vigils on this road by a crew of Fish and Game personnel proved that no less than 24 birds were involved, and that their point of passage across the road did not vary more than a mile or two; on some days none was seen.

Eight sightings during the following summer revealed an identical daily pattern. The maximum number seen was 28 birds. During these two years birds were seen on these flights between July 22 and early September.

During the past summer the first long watch for birds on this summer flight was made June 25, but none was seen or heard. The next day a cowboy reported 16 arriving at the Shipman ranch in the same area they had used in previous years. We believe this marks the very beginning of the flight in 1957. As time and weather permitted (on many days there were torrential rains at this altitude—5000 feet—during the time the evening flights were anticipated), long vigils were kept and many counts secured (Table 1).

By waiting in hiding in the area of their anticipated night roost it was possible to observe many family units closely, to distinguish adult from juvenile birds by means of plumage differences learned from study of the captives, and, on two exciting occasions, to see color bands. Thus the identity of birds on breeding ground and summering area was positively established by these marked tracers in the population. This lends credence to our attempt to show the probable identity of most of the flocks observed during the summer with those previously seen on the breeding ground, 10 miles to the south (Table 1).

The greatest number of Nene seen in any one flight was on July 9 when 35 left the night roosting area between the hours of 7:27 and 7:34 a.m. The difference between this number and the total of 27 known to have been on the breeding area may represent two or three other families from an undiscovered nesting area, or from Mt. Hualalai, or it may be the unemployed birds not yet old enough to have nested.

Thus the summer flight season—biologically equivalent to the wintering ground period for North American geese—extends from just after the summer solstice (June 21) through August. Individual family groups were seen near the south end of the flight line October 25, 1955 and September 10, 1956. This August-September-October period is again a season of movement with no predictable daily flights.

On August 28, 1957, we again found a pair of Nene at the little kipuka where nesting occurred the previous year. It is clear that the post-summer flights carry some birds back to the breeding area early. There were no fresh droppings found elsewhere on the breeding ground on this date and the droppings at the nest kipuka were all warm, indicating that these were the first birds to visit the breeding ground in many months.

In essence, the Nene's year is divided as shown in Table 2.

RESULTS OF ARTIFICIAL REARING

J. Donald Smith was responsible for the beginning in 1949 of the Board's official efforts to rear Nene at Pohakuloa. The experience during the first years was detailed in his 1952 paper. Beginning with two pairs loaned by Herbert Shipman and augmented by an additional pair the next year, the project has succeeded in rearing 36 young birds to maturity during eight years. The greatest number reared in any one year was 12, in 1956-57. This success is far from the hopes expressed at its inception, when Smith wrote (1952), "The major objective of this propagation venture is to produce 50 geese a year to be released into the wild to restock the natural range."

The hopes infused into artificial rearing projects seldom are realized, for the potential of the species is often confused with the practical results to be anticipated. That these results do not equal the hopes is no criticism of the project or its methods but merely suggests how little we know about keeping wild geese in captivity.

Meanwhile in England at the Wildfowl Trust a flock of 3 birds, again supplied by Herbert Shipman of Hilo, Hawaii, has produced 53 young in seven years.

Although both projects follow the practice of removing first clutches and putting them beneath foster mothers (Woodworth, 1956; Wildfowl Trust, Fifth Ann. Rep., 1951-52) the number of young has not been great despite the high fecundity of the females—some laying four clutches in one year.

The principal causes of failure with these eggs are the apparent infertility and poor hatchability. The data gathered from the Pohakuloa project during the past eight years are presented in Table 3. Of the 31 eggs believed fertile but failing to hatch, 22 succumbed at pipping or within a few days of pipping time. Infertility accounted for 39 per cent of egg failure and difficulty in terminal days of development for 11 per cent. Together these two factors are responsible for half of the failure of the Nene to achieve its breeding potential in captivity; many of the eggs listed as "cause of failure unknown" must also have fallen in these categories. The British experience has been very similar, (Wildfowl Trust, Annual Reports, Fifths, Sixth, Seventh, Eighth).

One of the most pressing research needs is for an investigation of the above two factors. Candling of eggs by the fourth day of incubation should permit ready separation of apparently infertile eggs so

TABLE 2. SEASONAL ACTIVITIES OF THE NENE

July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June
	SUMMERING										
	Flocks united in daily flights			NESTING							
				Pairs isolated, noisy						WANDERING	
		MIGRATION								Flocks uniting	
		Wandering and return to nest area									
						REARING					
						Families isolated, quiet					

that they can be properly fixed and preserved for subsequent sectioning and microscopic examination. Only in this way will we ever know whether the many supposedly infertile eggs are evidence of real infertility. That infertility may have arisen from inbreeding is quite likely because all captive stock in the world stemmed from a few original pairs in Mr. Shipman's flock. It is possible that the captives are becoming homozygous for a lethal gene causing death at such an early age that it is difficult to distinguish from infertility.

The high percentage of embryonic deaths near hatching time may be due to improper humidity relations during incubation. The Pohakuloa project is in an area of about 11 inches of annual precipitation, the breeding ground has about 75 inches and a much more uniform distribution.

Both the Hawaiian and the English rearing projects have two stated objectives: (1) the distribution of excess birds to other agencies able to care for and rear further stock to ensure against disease or local catastrophes wiping out the species and (2) the ultimate release of birds in the wild to augment the slim wild population remaining. When and how this should be done is not yet determined but serious attention must be given these questions for most previous rearing projects have ended fruitlessly. Delacour (1954: 149) has shown how 117 years of Nene rearing in Europe came to an end with the death of the last bird at his aviary in France in 1940. A previous effort was made in Hawaii at the Mokapu game farm in 1927. Here five pairs of Nene were built up to a flock of 42 by 1935, whereupon the flock was dissipated by gifts to poltical friends. All birds died or were released (without banding) and it is doubtful that any contributed young to the wild population (Smith, 1952).

To prevent recurrence of such a disaster and to seek best possible use of the birds being reared at Pohakuloa, the Board of Agriculture and Forestry supported the intensive work conducted during the past year.

MANAGEMENT RECOMMENDATIONS AND ACCOMPLISHMENTS

The breeding potential of the Nene is low because they rarely reach sexual maturity or lay fertile eggs in captivity until three or more years of age; their clutches average less than four; like other geese they rear but one brood per year; judging from the six pairs observed in the wild, an average of only two young are reared per pair in a good year. Thus the come-back of this endangered species must be slow in the wild as well as in captivity. The obvious results of this low breeding potential are shown by the fact that at the end of six years one pair of Nene can be anticipated to increase to a flock of 12 during which time a pair of mallards would have 1,456 descendants. Only greater longevity and lower adult mortality rates can enable the Nene to come back even slowly. It is the job of management to see that these can be realized.

The specific needs and the progress toward each are as follows:

First—The only known breeding ground must be kept intact and relatively free of disturbance from September through April each year to protect nests, flightless young and molting parents. A ten-year cooperative agreement has already been established between the Bishop Estate—owners of the land—C. Brewer & Co. who are managing the area as a cattle ranch under a 30-year lease, and the Board of Agriculture and Forestry. The agreement permits the Division of Fish and Game access to an 8,100 acre area for patrol, to conduct studies, post the area against trespass, and eliminate predators by any means. Thus the way has been paved for effective protection of this area so crucial to the survival of the species. The very existence of the Nene as a wild bird depends on the continued whole-hearted cooperation of the three agencies. If birds return to nest there every year the area should be made a permanent sanctuary.

For this area to function, it should have vigorous control of exotic predators—cats, dogs, pigs, and mongooses—all of which are nearly universal in Hawaii. Effective control of all four species could be attained by systematic spreading of poisoned meat baits in the little isolated kipukas utilized by Nene. The expense should not be great if this were done as a cooperative venture between the National Park Service and the Board of Agriculture and Forestry just before the Nene nesting season, preferably in August or September of each year.

Poison baits should be so placed that they will not be seen by the Hawaiian hawk (*Buteo solitarius*) which is itself an endangered species. The only other avian predaceous species is the Hawaiian owl, (*Asio flammeus sandwichensis*), a grassland species rarely found in Nene breeding range.

Second—The entire area used by the Nene in summer should be free of hunters and their dogs from July through October. Nearly all of the essential area lies in the Upper Waiakea and Hilo Forest Reserves where there are no roads and hence the only trespass would be by hunting parties. Therefore, the Board of Agriculture and Forestry closed this area of approximately 5,000 acres to legal access for the essential months of each year, starting July 1 of 1957. Although actual patrol can not be effectively maintained in sucn a primitive area the legal mechanism is now established and public cooperation should continue to improve. The needs for this closed area were clearly shown when one hunter was apprehended with a live Nene which his dog had caught there October 30, 1949. Two other first-hand accounts of dogs catching wild, full-winged Nene were secured.

Third—Artificial rearing in Hawaii must be continued. Although the Pohakuloa project has been hampered by lack of funds since the initial appropriation in 1949 was exhausted and no full-time man has been available for its supervision, already as many birds have been produced there as are known to remain in the wild. Not only does this ensure against extirpation of the species but will soon provide excess stock that can be released in the wild.

With so much invested in these birds in time, money and hope, they must not be dumped out, without experience in flying and food finding and without geographic knowledge of the present Nene breeding ground.

Therefore, it seems wise that a release area be acquired adjacent to the present breeding ground where birds can live under semi-confinement for several months as they acquire their wings after the normal flightless period. Here they could learn to search for natural foods in a predator-proof enclosure, make trial flights, go and return if they would until they established contact with the wild population at the normal flocking season in May and June. But money must be found to accomplish this objective.

Fourth—A continuing strong public relations program is most vital. The press, radio and the Honolulu TV station have been cooperating splendidly with the Division of Fish and Game in giving publicity to all of the Nene news. Only in this way can the people of the Islands stay aware of the plight of the Nene and become convinced that it is a matter of public concern.

A great step forward was made this last year when the Conservation Council induced the Territorial legislature to name the Nene as the official bird of the islands. In thus following the example of the states in naming one species as official bird they have given recognition to their largest endemic land bird and we hope have assumed a new obligation for its perpetuation. It is hoped that they will now provide funds needed to carry out the necessary restoration measures.

SUMMARY

The Hawaiian goose or Nene is probably the rarest species of waterfowl in the world. It was native only to the Hawaiian Islands and persists today only on the big island of the group. Its status both in the wild and in captivity reached an all-time low in 1950 when 17 birds were left in captivity and only 17 were known in the wild.

Since then two projects for the artificial rearing of Nene have been established, at Pohakuloa in Hawaii and the Wildfowl Trust in Eng-

land, and a summer flight of 28 wild birds was discovered. To learn more of the birds in the wild, to appraise the artificial rearing efforts and propose a place and method for ultimate release of Nene to the wild, the past year's intensive study was made. It extended from September 1956 to September 1957. The principal findings were as follows:

1. A circumscribed breeding ground of a few square miles was discovered adjacent to Hawaii National Park on the east slope of Mauna Loa at 6500 feet elevation.

2. One active nest and three old ones were found in a tiny kipuka (vegetated area surrounded by recent lava flows). This indicates a strong tradition for pin-point return to nesting area. Within 2½ miles of this nest we sighted Nene 31 times during the next six months.

3. Unlike other waterfowl, the Nene breeds on a declining day length. First egg dates from captive birds showed 33 clutches nearly equally divided before and after the winter solstice; they extended from October 29 to February 8. The nest in the wild must have been started October 20 as determined by back-dating from its hatching November 22.

4. The breeding ground contained at least six pairs known to have nested and it produced 13 young, one of which vanished on hatching day. No other mortalities were known and 12 young were reared successfully.

5. We distinguished seven pairs or families. One flightless adult and two broods of young were captured and color-banded.

6. Only one non-breeder was found in the wild—it assocated with a nesting pair. Others may have been elsewhere for a lone bird was reported, and scattered droppings were found months later, on another mountain 30 miles distant.

7. Renesting was not found in the wild but is readily induced in captivity when first clutches are removed. Some females have thus been induced to lay three or four clutches in one year. Renesting intervals at Pohakuloa have extended from 13 to 43 days.

8. The tropical latitude and mid-winter hatching time combine to give short days for feeding, and resulting growth rates are slow; 10-12 weeks are required for Nene young to reach flying stage.

9. As with other geese, adult Nene molt with their young and are themselves flightless for 4-6 weeks. Thus part or all of the Nene family is vulnerable to predation for three months or more each year.

10. All significant predators are terrestrial and introduced—cats, dogs, pigs and the mongoose are a menace to flightless geese. All could be controlled with poison meat baits placed in the breeding area early in the fall of each year.

11. Nene families remain isolated and quiet throughout the flightless period; flocking and calling begin by mid-May.

12. A wandering period of about a month follows during which Nene whereabouts can not be predicted; the last fresh sign was found on the breeding ground June 15. This period seems biologically equivalent to fall migration in continental waterfowl.

13. Nene are on their traditional summering ground from the solstice (June 21) into August. Morning and evening flights to and from the night roost are seen almost daily. The maximum number of birds seen was 35. This may well be all the Nene remaining in the wild.

14. Again this period is followed by wandering during which the birds occasionally visit both summer roost and breeding ground.

15. During eight years of artificial rearing the Pohakulua project has produced 36 young from a start with 3 pairs. In England 53 young have been reared from a start with three birds. The numbers in captivity undoubtedly exceed those in the wild and help provide some assurance that the species will not perish.

16. At least half of the eggs laid in captivity are either infertile or fail to hatch. Careful investigation is needed to discern whether the apparent infertility is real, for it is possible that much and long inbreeding may have resulted in the captives becoming increasingly homozygous for a lethal gene.

17. The very low breeding potential of the Nene, its precariously small population and the difficulties of rearing birds in captivity point up the following needs for management:

One—Permanent protection of the only known breeding ground both from human disturbance and predation by exotics introduced by man. Progress has been made by establishment of a cooperative agreement between land owner, lessee and the Board of Agriculture and Forestry. But it can be terminated by 30 days notice—and this is little time in which to alter the traditions of a species! Annual poisoning of exotic predators in this breeding ground is also clearly needed.

Two—The 5,000 acre summer reserve now closed to hunting and trespass for the period of July through October must be maintained.

Three—Artificial rearing must be continued and improved until sufficient surplus stock can be released to assure the status of the species in the wild. Money for maintenance and research is desperately needed.

Four—A release area should be acquired adjacent to the breeding ground, wherein stock to be liberated can be released when flightless within a predator-proof fence for conditioning to natural foods and flight before the normal flocking and flight season begins. Again money is necessary.

The success of these projects depends on continuing a strong public relations program so that the people of Hawaii will want to protect their new official bird of the islands and agencies elsewhere will give support to their efforts by helping to find adequate financing.

ACKNOWLEDGMENTS

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Members of the Division of Fish and Game who gave willingly of their time and helped whenever possible were Gene Burke, Joe Medieros, Roland Crisafi, Ernest Yap, John Perez, Ah Fat Lee, and Ronald Walker. Col. Bryan of the Department of Forestry gave much help and supplied unpublished records.

The Nene steering committee—Vernon Brock, John Woodworth, and Paul Breese—provided stimulating advice throughout the study. Others who gave special help were newscaster Wayne Collins, Albert McKenzie, and the National Park Service rangers.

Herbert Shipman graciously gave access to his ranches, both Puu Oo where the Nene make their summer roost, and Ainahou where his captive flock is kept. His courtesy and generosity and that of his foremen, Henry Haa and Tommy Lindsey, will long be remembered.

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TABLE 3. PRODUCTION AND FATE OF EGGS LAYED BY CAPTIVE NENE AT POHAKULOA, HAWAII—1950-57

Clutches layed	53
Total number of eggs	196
Average clutch size	3.7
Number of infertile eggs	77
Number with soft shells	2
Number cracked	11
Number of dead embryos	31[1]
Cause of failure unknown	33
Number of fertile eggs	79
Number that hatched	42
Number reared	36

[1]Including eight found "rotten" at end of incubation and assumed to be fertile because infertile eggs remained clear.

DISCUSSION

MR. ALBERT M. DAY [Oregon Fish Commission, Portland, Oregon]: My recollection is that the birds that were sent from Hawaii to England were more or less experimental and that the offspring were to be returned to the Hawaiian Islands if there were any surplus. Is that correct, or are they being merely kept in England as a museum piece in a zoological garden?

DR. ELDER: These birds were given to the project in England by Mr. Herbert Shipman. It was not a loan. He was the sole owner of the captive birds, and he gave the birds for the start of the project in England and for the start of the Hawaiian government project at Pohakuloa. It was his hope that birds might be released for restock from one or both of these sources. I believe it is the feeling of Mr. Scott and his group now that these birds may be distributed to others who may help to raise them in captivity until the stock in the future is assured.

DISCUSSION LEADER TACK: In reading over this paper, it occurred to me to ask whether the mongoose is present on all the Islands that might be suitable as a residence for this goose?

MR. ELDER: The mongoose is present on all the Islands except Kauai. I didn't visit Kauai so I can't give a first-hand summary of its ecology or an opinion on whether or not it would be suitable.

DR. TACK: I anticipate that you might find some difficulty in rehabilitating the pen-reared or domestically reared geese with the wild flock. Has this been given attention?

DR. ELDER: This is a subject of serious consideration at the moment. It is our recommendation that an additional area should be acquired, perhaps adjacent to the national park or certainly adjacent to the breeding ground where these birds can be released, flightless, under fence, with protection from predators so they can learn to find wild food and get their wings and fly, perhaps gradually, out from these areas until they take up with the wild population.

MR. ROBERT CURTIS [Michigan Department of Conservation, Munith, Michigan]: I wonder, Dr. Elder, if you have any ideas where the wandering you mention would take the flock? Did they wander between islands?

DR. ELDER: As far as our observations are concerned, their wanderings are only a matter of a few miles, perhaps twenty or thirty. There were no regular occurrences on the breeding or summering grounds during this period although they may be discovered at either place. There is some evidence that formerly the birds may have visited other islands. But we don't know in what seasons. The seasons are not well defined in the Islands, and it is difficult for the people to relate them today to these observations. So we do not know when they visited Maui and Molokai.

DR. TACK: In your paper you mentioned that it is rather difficult to contact natives who might give you valid observations. Would it be feasible or worthwhile to attempt to reconstruct the nature of the decline of this flock? You said that at one point there were thousands, and now they are down in the neighborhood of fifty.

DR. ELDER: Paul Baldwin did this in 1945 and 1947. He defined the range of the Hawaiian goose both historically and in recent years very well. His conclusion was that most of the observations were at a level of five to seven thousand feet on the mountains, and our observations fitted his very closely.

MR. DAVID E. PELGEN [Department of Water Resources, Sacramento, California]: I would like to ask Dr. Elder if anything is known of the origin of these birds, either known by others or speculated by your paper?

DR. ELDER: Dr. Alden Miller did the definitive study of the anatomy about 25 years ago, and he determined that they belong with the Canada geese in the genus *Branta*. The reduction in the size of the wings and the webbing of the feet indicate this bird has been away from water, and it has been comparatively flightness for many years. The bird has been on the Islands so long that it is very hard now to detect or determine what its source of origin may have been. Other members of this genus fly to the islands every winter or at least are seen there occasionally.

THE SIGNIFICANCE OF FARMLAND FOR WATERFOWL NESTING AND TECHNIQUES FOR REDUCING LOSSES DUE TO AGRICULTURAL PRACTICES[1]

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University of Missouri, Columbia, Missouri

Most studies of nesting waterfowl have been conducted on marshes and their immediate surroundings; relatively little is known of the importance of farmlands for nesting. The present study was conducted on the Portage Plains of Manitoba to provide information on farmland nesting.

On the Portage Plains, as elsewhere in the great wheat belt of Canada and the northern plains states, large areas are covered by shallow water as the snow melts. In early April, pintail (*Anas acuta*) and mallard (*A. platyrhynchos*) pairs are commonly seen sitting in stubble fields near such water areas. Many of the early nests are lo-

[1]Contribution from the Delta Waterfowl Research Station and the Missouri Cooperative Research Unit: U. S. Fish and Wildlife Service, Wildlife Management Institute, Missouri Conservation Commission, Edward K. Love Foundation, and University of Missouri cooperating.

The author acknowledges the help of William H. Elder, Rucker Professor of Zoology, University of Missouri, and H. Albert Hochbaum, Director, Delta Waterfowl Research Station, for direction and advice; Merrill Hammond, Biologist, U. S. Fish and Wildlife Service, for use of unpublished data; Thomas Baskett, Biologist, U. S. Fish and Wildlife Service, for reading the manuscript. Thanks are also extended to Frank McKinney and Peter Ward of Delta and to the many farm people on the Portage Plains who cooperated in the study.

cated in the stubble fields, for as Lynch (1947) pointed out, there is little other cover available on farmlands until June, when new growth of grasses is substantial. The pintail is the species most attracted to stubble fields probably because (1) they commonly nest in sparse vegetation, even when heavier cover is available (Bent, 1923), and (2) they frequently nest at considerable distances from water (Kortright, 1942).

Stubble field nesting has been observed in several localities, and heavy losses of the nests due to agricultural practices have frequently been reported.

In North Dakota, Merrill Hammond (unpub. ms.) found a large proportion of pintail nests in grain stubble, and nearly all of these were turned under as spring farming operations progressed. In southern Saskatchewan, Lynch (1947) mentioned the serious loss of pintail nests in stubble fields due to spring plowing; later Gollop and Lynch (1954) reported that for the second successive year agriculture aparently ruined the chances of a "super" duck crop because of plowing under of pintail and mallard nests in the stubble fields.

Some farmers move stubble field nests from the path of their farm machinery, and according to Hammond's (unpub.) data, this practice has merit. However, Dzubin (1952), working in the Minnedosa pothole district of Manitoba, thought that few if any of the stubble field nests moved by farmers hatched successfully, because they were readily found by crows and other predators.

The present study was started in 1956 with these specific objectives: (1) to determine the species composition of waterfowl nesting on agricultural land; (2) to measure the losses of nests and nesting hens from farming practices; and (3) to learn what changes could be suggested to reduce these losses.

The study area extended thirteen miles along the border of the Delta Marsh and ten miles to the south; a few farms as far as 25 miles south were also studied. Because it was impossible to cover such a large area alone, the help of farmers was obtained.

The biggest problem was overcoming the bias the farm people felt toward waterfowl. Since the early 1920's they have suffered from waterfowl depredations on unharvested grain in the autumn. The farmers felt their problem had not been given the attention it deserved. Many hours of explanation and effort were spent in convincing each farmer on the study area that I would look into his problem if he would help me with mine. In 1957, thirty-four farmers were cooperators and their lands had the following acreages: stubble 10,796 acres; fallow 3,171; hay 1,415; and pasture 560.

The best method of finding nests was to accompany the farmer as

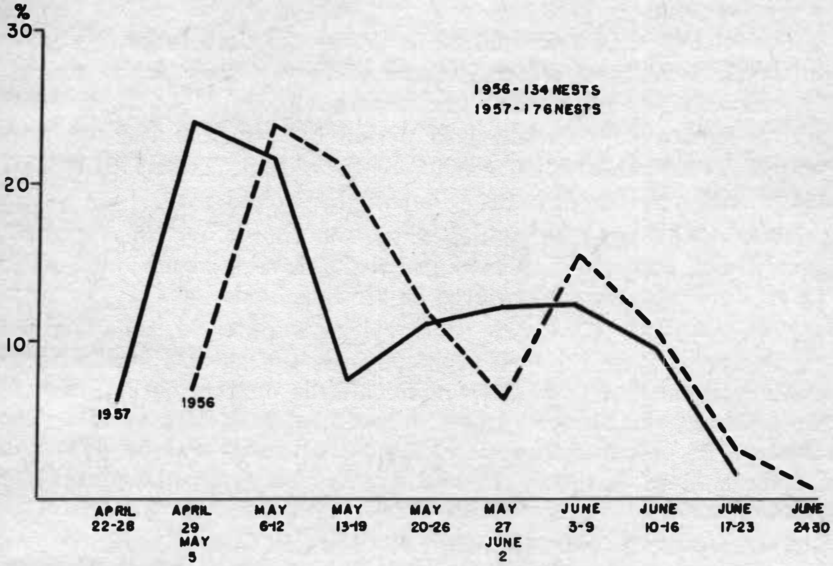

Figure 1. Nesting chronology of the pintail as determined by the percentage of nests initiated each week of the season.

he worked his fields during cultivation, mowing, and spraying. The farmer covers the fields more completely with his tractor than could be done by walking with dogs or by dragging a rope. Each farmer was given brightly painted stakes three feet long to mark each nest he encountered during the day.

Moving Nests. When a farmer on my area moved a nest he got off his tractor and scooped out a shallow bowl. He then placed his hands under the nesting material and lifted the nest and eggs over into the new bowl. In almost all cases the eggs were left exposed. Some nests were moved as many as six times.

Working Around Nests. This procedure requires less work than moving nests but may be less acceptable to the farmer because of the difficulty he encounters in planting his rows of grain straight.

Farmers with hydraulic lifts on their tractors preferred to work over nests rather than to get off the tractor to move them. With this equipment they did not have to veer off but merely raised their equipment over the nest.

Some farmers spared hayfield nests by mowing as close to them as possible from both sides, leaving only a few stems of hay standing. Others raised their cutting bar several inches when encountering a nest.

RESULTS

Arrival Dates. Pintails and mallards are the first ducks to appear on the fields of the Portage Plains and they usually arrive paired. The arrival times are surprisingly uniform. Sowls' (1955:12) average arrival dates over the twelve-year period 1939 to 1950 at Delta were April 2 for the mallard and April 5 for the pintail. From 1951 to 1957 they varied only two days from those he had found.

Later, bluewinged teal (*A. discors*), shoveller (*Spatula clypeata*), gadwall (*A. strepera*), greenwinged teal (*A. carolinensis*) and baldpate (*Mareca americana*) arrived on the farmland.

Nesting—1956. The entire countryside abounded in large fields of "sheet water" from the melting of 96 inches of snow. Pintails began nesting on the fourth of May and mallards on the tenth. Peaks in the nesting period were reached a week later in both species. The duration of nest initiation dates for pintail nests was 52 days and for the mallard 54 days. The nesting chronology for the pintail for this and the following year is shown in Figure 1.

Nesting—1957. Only 51.6 inches of snow had fallen, therefore there was less "sheet water." The first pintail nest was found on April 26 and the first mallard nest two days later. As in the previous year, nesting peaks followed by one week. Again the duration of mallard

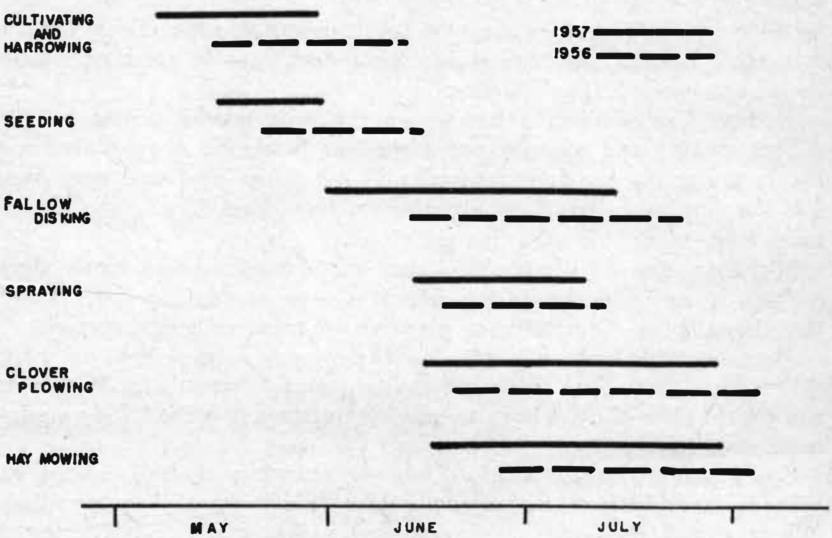

Figure 2. Phenology of agricultural practices on the study area.

nest initiation was several days longer (59 days) than the pintail (54 days).

Farming Practices. Most farmers in the Delta areas do not use a plow in the spring, and the loss of pintail nests was due to cultivation. In 1956, cultivation was delayed because of the standing water in the fields. Farmers started working their fields in the second week of May but the majority did not start until the third week. In 1957, cultivation started during the first week in May because the land was drier. The phenology of all agricultural practices on the study area is shown in Figure 2.

Seeding began about a week after cultivation in both years. After seeding, which lasted for about two weeks, the farmers began disking land that was to be summer-fallowed. This operation lasted for six weeks in both years.

Spraying of the grain fields for weed control was the next operation; it began in the third week of June in 1956 and the second week of June in 1957. This operation coincides with the plowing of clover for green manure.

The last farming operation to take place on the farmland was mowing of haylands. It started on the first of July in 1956 and two weeks earlier in 1957.

Influence of Farming Operations on Nesting. A cultivator sometimes passes over a nest without destroying it but usually the nest is partially or completely buried. In some cases, pintails dig out nests cultivated under by the farmer and are found sitting on them the next day. The delay in spring farming operations in 1956 caused high mortality among first nests. The earlier beginning date for cultivation in 1957 resulted in destruction of fewer nests because some of the hens had not begun nesting. The earlier start in 1957 also gave the hens a longer renesting period, boosting the total success from 6 per cent in 1956 to 25 per cent in 1957.

In 1956 pintail aerial chases were very common in the third week of May; this was directly connected with the destruction of nests during cultivation the previous week. Again, in 1957, the same sequence was observed after cultivation. Sowls (1955:138) saw pintail pairs gathering south of Delta in June, and suggested that some pairs wander after nest destruction. I am convinced that these paired pintails are birds that have lost nests in May and early June due to farming operations. When groups of pintail hens appeared in the marsh, six were collected each year (July 15, 1956, and June 26, 1957). Every bird showed a distinct brood patch, indicating that she had incubated for at least a few days. These hens had undoubtedly given up nesting after losing several nests to agricultural practices.

First nests in clover and alfalfa sprouting in old stubble fields are usually successful because they hatch before mowing time. But renests in clover are usually destroyed because they are started too late to hatch before mowing begins. In years of early nesting some hens using clover fields may be successful.

Nests in fields that are to be summer-fallowed are more likely to succeed than those in fields that are to be planted to grains because the farmer discs the fallowed land later.

Pintail nest losses from mowing on haylands were not as great as from cultivation. Seven of thirty-seven hayfield nests of pintails were destroyed in the two years. Mowing losses of the mallard and teal were higher because these species more frequently use hayland for their first nests.

The practice of plowing clover for green manure is more destructive than mowing because a nest can seldom be saved when plowed under, but when mowed over some hens will return and successfully hatch their eggs.

Farming operations on the Portage Plains destroyed 57 per cent of th pintail nests located in 1956 and 41 per cent in 1957. In descending order of destructiveness these operations were (for the two years combined): cultivation, disking, mowing, plowing, and harrowing (Table 1).

There were 560 acres of typical farmland pasture on the study area. Most of it lay five miles south of the Delta Marsh. There were 290 cattle on this area, or about two acres per animal. This is considered

TABLE 1. CAUSES OF FAILURE OF PINTAIL NESTS FOUND ON FARMLANDS, BY TYPES OF COVER, 1956-1957

Causes of failure	Total number	Stubble	Roadside	Fallow	Pasture	Hay	Growing grain	Woods	Field edge	Marsh edge	Creek edge	Fence row
Cultivation	99	84		12		1			1	1		
Disking	9	9										
Mowing	7					7						
Plowing	5	1				4						
Spraying	3						3					
Harrowing	1	1										
Predators	65	12	17		7	9	3	1	12		2	2
Flooding	8	6					1		1			
Burning	2	1	1									
Observer	3		1					2				
Miscellaneous	3	1	2									
Unknown	18	8	6			3						
Total failed	223	123	27	12	7	24	7	3	15	1	2	2
Total hatched	39	9	5		9	13	1		1	1		
All nests	262	132	32	12	16	37	8	3	16	2	2	2

heavy grazing density, but 30 per cent of the duck nests (of five species) were successful. In fairly heavily grazed pastures, plant species unpalatable to cattle thrive and serve as good nesting cover.

In this study no birds were marked, therefore hens renesting could not be individually identified but renests were classified as such by inspection of the nesting chronology. All nests found after the low-point (Figure 1) were arbitrarily classified as renests, as Sowls (1955:140) did in his study. Therefore all nests found after May 19 in 1957 were classified as renests and all after June 2 in 1956 were so classified.

In 1956, 29 per cent of 134 pintail nests were renests and in 1957, 43 per cent of 176 were renests. About 11 per cent of the first nests were successful, but 21 per cent of the renests hatched, demonstrating the significance of renesting in the pintail. Locations of renests for the pintail are shown in Figure 3. Similar data from Sowls (1955:140) found that 25 per cent of pintail nests were renests in 1949 and 44 per cent in 1950, when "spring plowing on the Portage Plains took an abnormally heavy toll of pintail nests during the peak of the nesting season," according to Sowls.

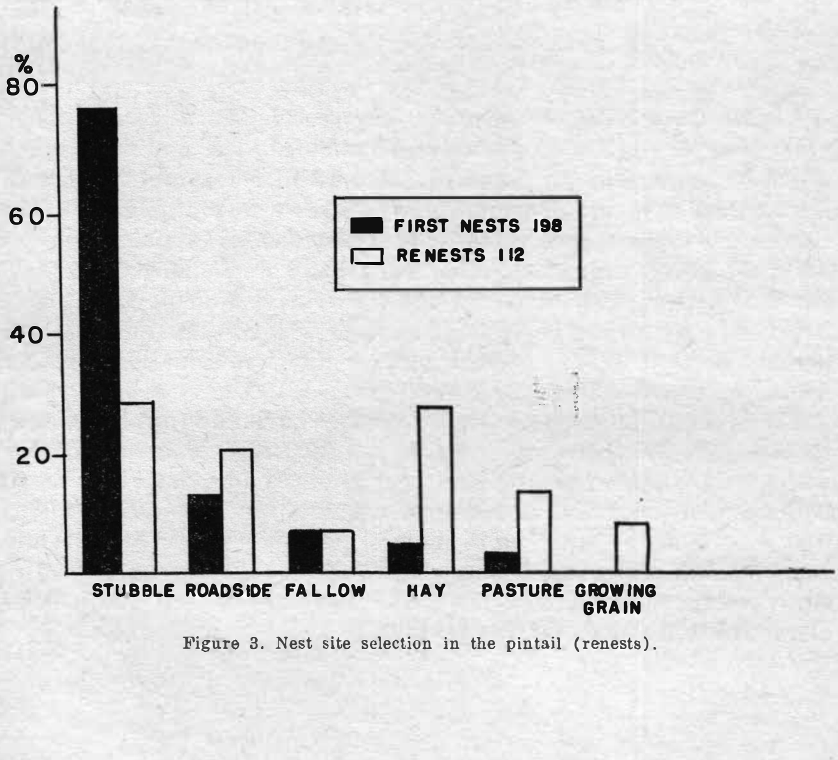

Figure 3. Nest site selection in the pintail (renests).

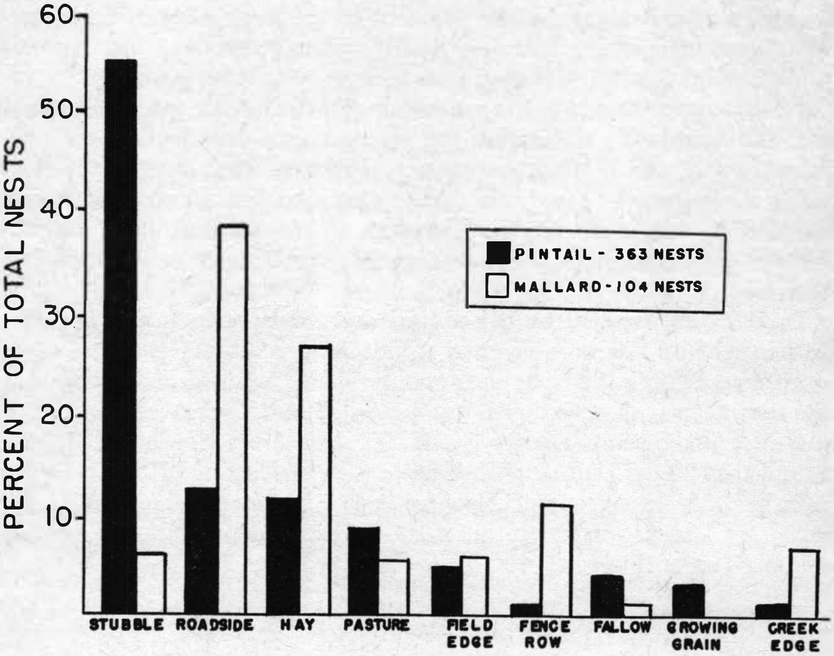

Figure 4. Nest site selection in the pintail and mallard.

Nesting Cover Types and Species Preferences. On the farmland 608 nests of seven species of ducks were examined. The nesting sites selected by these birds are listed in Table 2 and percentages of pintail and mallard nests in different cover types are shown in Figure 4. The remarkable preference of pintails for stubble fields is apparent.

On the 15,852 acre study area, 441 nests were found. Of these 59 per cent were pintails, and about 24 per cent were mallards. Stubble fields had a density of one pintail nest per 48.9 acres in 1956 and one per 58.5 acres in 1957. Although lacking any significant cover, fallow fields had an average of one pintail nest per 100 acres in both years.

The highest nest densities were found in haylands (alfalfa, clover, brome). In 1956 there was one nest per 10.3 acres and in 1957 one nest per 11.9 acres. Pastures contained one nest for about 14 acres in both years of the study. Roadsides along the study area contained one nest per 0.68 miles in 1956 and one nest per 0.56 miles in 1957. Oddly enough, creek edges, which were very numerous throughout the entire study area, contained very few nests. Fence rows were much more attractive to mallards than to pintails.

Predation. On the study area 25 per cent of the 262 pintail nests and 53 per cent of the 93 mallard nests were lost to predation. The predation picture appears to vary with each farm. If a farm is surrounded by woods, the crows (*Corvus brachyrhynchos brachyrhynchos*) nesting in the nearby trees will cause considerably more damage than in areas lacking crow-nesting sites.

TABLE 2. SPECIES COMPOSITION AND NEST SITE SELECTION IN FARMLAND NESTING

Nest site	Pintail	Mallard	Blue-winged teal	Shoveller	Gadwall	Baldpate	Green-winged teal
Stubble	197	6					
Roadside	44	40	8	9	9		3
Hay	39	27	24	9	8	3	
Pastures	21	5	16	3	4		
Field edge	17	6	4	1	1	1	
Fence row	4	12	7	3			
Fallow	18	1					
Marsh edge	4	6	8				
Woods	6	5	3	1	2		
Growing grain	11			1			
Creek edge	2	7	1	1			
Total	363	115	71	28	24	4	3

In the present study foxes (*Vulpes fulva*) destroyed at least eight nests. There was one instance in which a fox apparently learned that the stakes in two clover fields were marking nests because all five of the marked nests were destroyed by a fox or foxes. Striped skunks (*Mephitis mephitis*) were very abundant in both years of the study. They were seen searching the hay fields in daylight as well as night. This species was known to have destroyed about 7 per cent of the pintail nests and 51 per cent of mallard nests on farmland. The greater vulnerability of the mallard nests is undoubtedly due to their preference for the taller cover of road sides, fence rows, creek banks and haylands as shown in Figure 4. Of more than 600 nests visited in the present study only seven were found with dead hens. Five were killed on the nest by predators and two by mowing operations. This is in sharp contrast to the high rate of loss of hen pheasants due to mowing reported by Dustman (1950).

TESTS OF TECHNIQUES FOR SPARING DUCK NESTS

The pintail is the most important breeding duck on prairie farmland, and the major period of its first nesting and renesting coincides with that of farming activities. Therefore any method whereby a large proportion of their nests can be saved from destruction during spring farming operations should result in greatly increased production.

There has been considerable conjecture as to how successful nest-moving operations really are. Hammond (unpub. ms.) stated that the value of moving nests during farming operations is certainly not to be questioned. In North Dakota he found that of thirty-one pintail and mallard nests moved, 32 per cent were successful. The nests were moved with no protective cover other than a handful of straw that the farmer might add to cover the eggs.

In the present two-year study, fifty-four nests of four species were moved. In moving a nest in old stubble being disked, a farmer had to get off his tractor three to six times before completing the field. The distance he moved the nest varied from five to fifteen feet. Several were moved as far as fifty feet with success. Of forty-eight pintail nests moved on stubble, 27 per cent were successful.

Hammond found the crow taking 18 of 31 moved nests. In the present study skunks and crows were the most destructive, accounting for 23 per cent of the manipulated nests. Although desertion rate in Hammond's study was low, in my study it was the principal factor involved in failure and caused half of the losses. This was true despite the fact that almost all of the moved nests were well along in incubation. Crows watch the farming equipment from nearby vantage points. They either see the female duck as she flushes or investigate the site where the farmer stops and momentarily leaves his tractor.

Several methods for saving nests were tried on the farmlands. Farmer cooperators with hydraulic lifts on their tractors raised their equipment over nests with little loss of crop and without disturbing the nests. Another method was to work from both sides as closely as possible to the nest with the farm equipment and leave the nest intact without leaving a nesting ''island.'' Of twenty-seven such nests in stubble and summer fallow, seventeen (63 per cent) were successful. This compares very favorably with the average success rate of 60 per cent reported by Kalmbach (1939) for ducks.

Desertion appears to be the critical factor involved in moving of nests, but it is not in working over or around them. Therefore, it appears that this technique is by far the better, and with the numbers of farmers using hydraulic lifts increasing, it can become a valuable management tool in saving pintail nests.

Protecting Nests in Hayfields. Previous studies have recommended leaving large unmowed "islands" around nests in hayfields (Labisky, 1957). But farmers can not be expected to waste large patches of hay by leaving these "islands." In my study area farmers were asked to leave as little as possible around each nest found. Of nine nests so treated, three hatched successfully. Other farmers raised the cutting bar and passed over the nest; four out of five of these were successful

Ducks Eggs Collected From the Farmland. Because seeding was delayed by wet weather in 1956, farmers could not take time to move or work around nests in stubble. In order to save the eggs that would have been cultivated over, the farmers were requested to set them aside for delivery to the Delta Waterfowl Research Station. For many years the Station has collected eggs from the marsh to rear in the hatchery (Hochbaum, 1944), but not from the farmlands. Hatching success of these pintail eggs from the farmlands was 82 per cent as compared with 73 per cent for pintail eggs from the marsh.

In addition, 131 pintail eggs in all stages of incubation were sent by air to the Delta Station by J. B. Gollop of Saskatchewan. Eighty-six per cent of these hatched successfully.

It appears that collecting and hatching eggs from doomed nests on farmland can be used as a practical management technique, especially with the pintail. It would seem that if enough publicity were provided, many thousands of eggs could thus be collected and hatched.

SUMMARY

1. Because most studies of nesting waterfowl have been conducted on marshes and their immediate surroundings, little is known of the significance of farmlands for nesting. This study was conducted during two summers on the Portage Plains of Manitoba and most work was concentrated on a 15,850 acre area extending ten miles to the south of the Delta Marsh.

2. During the study, 608 nests of seven species of ducks were examined. The pintail was by far the most abundant species, providing 363 nests. Other species were mallard, bluewinged teal, gadwall, shoveller, baldpate, and greenwinged teal.

3. The preferred first nesting site for the pintail was in stubble. Of 198 first nests, 72 per cent were in stubble. Pintails prefer fall-disked stubble to fall-plowed or intact stubble. Only 6 per cent of the mallard nests were in stubble.

4. Farming operations on the Portage Plains destroyed 57 per cent of the pintail nests in 1956 and 41 per cent in 1957. Early cultivation took the heaviest toll. In descending order of destructiveness, the farming operations were: cultivation, disking, mowing, plowing, and harrowing. Only 6 per cent of the pintails found on farmlands were successful in 1956 but 25 per cent succeeded in 1957.

5. Hay lands were important for five species of waterfowl: pintail, mallard, bluewinged teal, gadwall, and shoveller. Only two hens out of 110 hayfield nests were killed by mowing operations.

6. Pintails that renest late in hayfields have little chance for survival because haying starts shortly after incubation begins. Important

sites selected by 112 renesting pintails were as follows: 28 per cent in stubble, 27 per cent in hay, 20 per cent on roadsides.

7. Of 310 pintail nests, 198 were first nests and 112 were renests. Nearly 11 per cent of the first nests and 21 per cent of renests were successful.

8. After cultivation begins, and again later during mowing there was a reoccurrence of aerial chases due to the destruction of pintail nests.

9. Leaving nesting ''islands'' in hay was not found practical on private lands. A new technique was tried with success in this study: leaving the smallest possible area unmowed—actually only a few stalks. Mowing over nests was also tried with success.

10. Predation on mallard nests was twice as great as on pintails because the mallard prefers tall cover, as does the mammalian predator.

11. It appears that collecting and hatching eggs from doomed nests on the farmland can be a practical management technique—especially with the pintail. Of 491 pintail eggs so collected, 82 per cent hatched successfully in the incubators at the Delta Waterfowl Research Station.

12. In the present study 27 per cent of the forty-eight moved nests were successful. Desertion rate appears to be the critical factor involved in moving nests. Of twenty-seven worked-around pintail nests, 63 per cent were successful. While the success of moved nests was not high, the success of worked around nests was surprising and suggests that here may be another new practical technique for increasing pintail production on the farmland.

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DISCUSSION

MR. CLAIR T. ROLLINGS [U. S. Bureau of Sports, Fisheries and Wildlife, Minneapolis, Minnesota]: I believe, you said that, in leaving cover when the nest was discovered, it was best to leave a minimum amount of cover, a few spears of vegetation, rather than a block of forty or fifty feet. Why do you believe the smaller amount of cover is more successful?

MR. MILONSKI: I meant to say that the farmer on the prairie will not leave large blocks of standing alfalfa or clover. Therefore, since he won't leave it, we do the next best thing and save the nest and a few sprigs of cover.

MR. ROLLINGS: Do you believe a larger block would attract predators?

MR. MILONSKI: I don't think so. Ron Labisky had a similar study. He dealt with hayfield nests and realized a fifty percent success. He used an area about twenty-five feet square.

MR. ROLLINGS: Do you think a minimum amount of cover would attract fewer predators?

MR. MILONSKI: I think so, yes, personally.

MR. JO VALENTINE [Greenfield, Illinois]: My experience has been that if you leave a very large patch of alfalfa, the first thing the dogs and foxes do is go there to see what you left it for. If you skip a little, they are used to you missing something. We never have predator trouble at all, and we used to raise mallard ducks. Crows, cats, foxes, and house dogs worked on them a lot, so I put out a few poisoned eggs. That ended that.

MODERATOR TACK: Thank you for the comments.

MR. DON P. BRADSHAW [Duck and Hunters Association, Alton, Illinois]: Mr. Milonski, do you have any idea how many ducks a year are lost through farming activities?

MR. MILONSKI: I don't know but it is a great number.

MR. BRADSHAW: It sounds like it. You say disking in the fall is preferable to plowing. Is there any chance of persuading the farmers to make that a general practice?

MR. MILONSKI: You could persuade some of the farmers around the Delta region where I performed my work.

MR. BRADSHAW: That is a big producing region?

MR. MILONSKI: Well, not the largest. Some parts of Saskatchewan are much better producers. They produce more pintails than we do.

MR. BRADSHAW: What is the worst predator on mallards?

MR. MILONSKI: The skunk.

MR. BRADSHAW: It there any control program on that? Either by sportsmen's clubs, government or otherwise?

MR. MILONSKI: There was a crow campaign in that area several years ago and they killed quite a few crows in the area. The crows are not as numerous as they were ten years ago. But skunks are very numerous right now.

MR. ROBERT D. CURTIS [Michigan Department of Conservation, Munith, Michigan]: I made a study in south central Michigan at an experimental station on which we had a unit of approximately 700 acres. The farmers would leave patches of cover and of eighteen pairs of mallards in an area of three thousand acres, I had nine broods that came off. But our farming operations, as I said before, were tied directly with the wildlife program. I think if the farmers in southern Michigan or any part of Michigan would carry on programs of that type, our nesting population and production itself would increase.

There have been a number of studies in Michigan. I notice you mention there weren't too many studies carried out on farms, but there have been a number in Michigan on productivity of waterfowl.

MR. MILONSKI: You said mallard? In stubble fields or hay fields?

MR. CURTIS: They were using hay just for cover.

MR. MILONSKI: I only found six per cent mallards nesting in stubble fields compared to almost eighty per cent pintails. That is a big misconception on the prairies. Everybody says mallards and pintails are nesting out there. They are not. The mallards are around the fringe areas, reedy areas and ponds.

DISCUSSION LEADER TACK: Is there evidence of homing among these ducks, particularly the pintail, to the same nesting area?

MR. MILONSKI: I had no marked birds, so I could not say so. I think there was. It has more or less been proven.

RECREATION, FISH, AND WILDLIFE IN CALIFORNIA'S WATER DEVELOPMENT PROGRAM

DAVID E. PELGEN

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California is presently faced with a problem of the most critical nature—the need for more complete control and conservation of her most vital resource—water. The critical nature of this problem stems not only from unprecedented recent growth in population, industry, and agriculture in a semiarid state, but also from the consequences of a long period during which the construction of water conservation works has not kept pace with increasing water demands.

Another critical problem facing the State is the need for more facilities and opportunities for outdoor recreation. Increases in leisure time, a higher standard of living, a vastly improved highway system, and other factors have resulted in demands for outdoor recreation increasing much more rapidly than the population is growing. We have already reached the point of saturation in the use of some recreation waters in heavily populated southern California.

The two problems just mentioned—water supply development and outdoor recreation—are interrelated in many aspects. In fact, we are beginning to realize that water and outdoor recreation are virtually inseparable.

My purpose here today is to tell you something of California's water development program, and how we are including plans for fisheries, wildlife, and recreation in the *initial* phases of planning for water development projects.

THE CALIFORNIA WATER PLAN

The State Department of Water Resources has recently completed The California Water Plan. The plan, nine years in the making, is a master plan to guide and coordinate the planning and construction by all agencies of works required for the control, protection, conservation, and distribution of California's water resources for the benefit of all areas in the state and for all beneficial purposes. It is conceived as an ultimate plan; one that will meet the requirements for water at some unspecified but distant time in the future when the land and other resources of the State have essentially reached a state of complete development.

The California Water Plan calls for the ultimate construction of some 260 major dams and reservoirs, an aqueduct system running virtually the length of the State, power plants, pumping plants, tunnels and conduits.

In order to fully appreciate the scope of The California Water Plan one must understand something of the occurrence of the State's water resources. As many of you know, the big water problem in California is not one of over-all shortage, but of maldistribution both as to geography and to time of year. Geographically, the major sources of water are in the northern part of the state where they flow into the ocean virtually unused, while the productive land and major urban and industrial areas are located in the central and southern regions where water supplies are insufficient.

The picture is further complicated by the fact that most of the water, in the form of runoff, occurs during the late winter and spring months, while the major water requirements are in the summer and fall.

As a result, a major concept of The California Water Plan involves the capture and storage of water on the major rivers in northern California—the Klamath, Trinity, Eel, and Sacramento, and an aqueduct system to transport the water the full length of the state to areas of deficiency. This major storage and conveyance network—called the California Aqueduct System—would ultimately develop nearly 22,000,000 acre-feet of water each year, and transport it to areas where it is needed.

The Feather River Project, with an estimated capital cost on the order of one and one-half billion dollars is the first unit of The California Water Plan. It will be the first implementation of the concept of delivering surplus northern California water to deficient areas in the southern part of the state. Its major feature, Oroville Dam, is already under construction.

The State Legislature, in the act calling for a master plan for the ultimate development of the state's water resources, recognized the impact that this plan might have on outdoor water-associated recreation. It specifically directed that the plan ". . . give full consideration to all beneficial uses of water, including fisheries, wildlife, and recreation. . . ."

Recreation Considerations in Initial Planning

With the passage of this act it became possible for the first time to include provisions for maintaining fisheries, wildlife, and recreation resources in the initial planning phases of water development projects. Prior to this time the state agencies responsible for fish and game, and for the development of recreation areas, reviewed water development plans only when the projects were ready for construction, or at best, in the final planning and design stages. As a result, features for preserving or enhancing recreation were difficult to incorporate in project plans. Even though they might involve relatively small quantities of water or simple facilities, they would have disrupted already firm plans, and project sponsors were reluctant to provide them.

The State Department of Water Resources, in complying with the directive of the Legislature, contracted with the Department of Fish and Game for biologists to participate in the development of The California Water Plan. The biologists, though they remain Department of Fish and Game employees, work in the offices of the Department of Water Resources, and their salaries and operating expenses are borne by the water resources agency. By maintaining this close working relationship, the recreation planners become full-time participants in the planning process, and are best able to give and receive ideas as project plans begin to take shape.

By this process we have received something that we have been asking for for many years—participation in the planning of water development projects. Both of the agencies have been pleased with the results, and the program has expanded since it was begun. Starting with one fisheries biologist several years ago, we now have four; and we plan to add our first full-time game biologist this year. The State Division of Beaches and Parks is now participating in the program, and planners from that agency are now working with us on problems of public recreation facilities, access, and evaluation of the many forms of water-associated recreation other than fishing and hunting.

We feel that we are developing a well-balanced recreation planning program, and we know that we are accomplishing things that were formerly beyond our reach. Naturally, the program has its frustrations. The mere presence of a few fisheries biologists does not assure that future water projects will not displace valuable fisheries or recreation resources. The planning process is largely a matter of give and take. It involves the development of a plan or plans which will provide for the use and perpetuation of the resources which are being planned for, within the limits of being compatible with competing uses, requirements, and resources. Thus, we frequently receive a stream flow release below a diversion structure, for example, that is less than the optimum flow for maintaining a fisheries habitat. At the same time, however, the irrigator or the developer of hydroelectric power often receives less water than he had originally set his sights on. We all claim to be interested in multiple-use planning of water projects, but I suspect that most agencies and groups have their own definition of multiple-use; one which places their particular use at the top of the list.

The California Fish and Game Commission, in 1952, adopted a policy regarding water projects which has been a basic guide to the planning section I am speaking of today. The policy statement recognizes that water resources developments are essential to the economy of the state, and that they must and will be built. It calls for recognition, however, of the fact that water for fisheries, wildlife, and recreation is fully as important to the economy of the state as that for some of the other beneficial uses, and requests that these uses be carefully considered in planning water resources developments. It further requests that efforts be made to enhance, not merely preserve, fisheries, wildlife, and recreation values.

ACCOMPLISHMENTS OF THE PLANNING PROGRAM

What has the planning program accomplished in the four or five years of its existence? Since we are working in the initial planning phases of water resources development we have nothing concrete to point toward in the form of completed projects or operating facilities. The time lapse between planning water projects and constructing them often covers many years. Our accomplishments to date must be measured by project reports that indicate the fisheries and wildlife considerations that have been integrated into their planning, and, equally important, by the concept among water agencies in California that recreational benefits or detriments are basic considerations in water developments. Through the efforts of the agencies with whom we work, the uses of water for fisheries, for wildlife, and for recreation have recently been legally defined as beneficial uses of water in California.

Thus far in the program, the problems concerning fisheries have been most demanding, and most of our efforts have been directed toward solving them. I might briefly mention the scope of our fisheries activities in The California Water Plan and in subsequent more detailed investigations recently initiated by the Department of Water Resources.

We recognize three broad areas in fisheries where water developments are concerned. First is the North Coastal Area, the lowlands of the Sacramento River Basin, and the Sacramento-San Joaquin Delta. These are the areas most important to anadromous fisheries, and also the areas where surplus waters are to be developed. Our efforts here are directed toward preventing losses to salmon, steelhead, striped bass, shad, and sturgeon runs. Our tools are fishways, fish screens, hatcheries, artificial spawning channels, and scheduling water releases to remaining stream beds. We have gone beyond streams which are scheduled for development of their surplus waters, and have planned stream flow maintenance projects on rivers where no other developments were planned.

Those of you who live in areas of rather uniform precipitation find it difficult to understand the fisheries problems presented in an area where we have a six-month rainy season and a six-month dry season. Fluctuations in stream flow are tremendous under such conditions. The Eel River, one of our major north coastal salmon and steelhead streams, has recorded a low flow of 16 second-feet and a high flow of one-half million second-feet. Normal September flows are on the order of 135 second-feet, and normal January flows are about 19,000 second-feet.

Under such widely variant flow conditions it is apparent that fish populations have their troubles. One of the most serious is low flow in the summer and fall. In recognition of this fact the concept of stream flow maintenance became a major concern to us; particularly on salmon and steelhead streams that were not scheduled for other development. Stream flow maintenance projects offer the primary benefit of providing sustained ample flows during the low-flow periods, and secondarily, reducing the peaks from winter floods. The reservoirs constructed for this purpose will also support resident fisheries and be available for general recreational use.

In planning stream flow maintenance projects, a dam site near or above the upstream limits of steelhead migration is selected, if possible. The size of the dam and reservoir takes into consideration the quantity of stream flow desired in downstream areas, and the amount of holdover storage required to retain the recreational characteristics of the reservoir.

Altogether, 13 such stream flow maintenance projects were included in The California Water Plan. They would greatly enhance the salmon and steelhead habitat in 416 miles of streams, and provide other benefits as well.

The second broad area where fisheries will be affected by water developments includes the mountainous areas; the Sierra Nevada, the Cascades, and other ranges throughout the state. Streams, lakes, and reservoirs in these areas support trout fisheries. Self sustaining fisheries exist in streams where access is difficult, and catchable sized trout are planted in roadside waters. A great deal of water development has occurred on California's mountain streams; much of it for hydroelectric power purposes. Future developments will generate power, but will serve conservation, flood control, recreation, and other purposes as well.

Primary fishery considerations in these areas are the maintenance of sufficient flows below dams and diversions, and providing for the operation of reservoirs in a manner most nearly compatible with their recreational use. We have pursued the concept of stream flow maintenance on trout streams with some success. Three recreation dams and reservoirs in the Upper Feather River have been authorized as units of the Feather River Project. These projects were planned and justified on their merit as stream flow maintenance and reservoir projects. Funds for their construction are being considered by the State Legislature at its present session.

The third general area of our fisheries planning is in the water-deficient portions of California. Here we have very little to lose and, with careful planning, everything to gain. Streams in these areas are largely intermittent, and provide little fishing or recreation of any sort. The worthwhile fisheries that do exist have been developed in reservoirs. They are typically warmwater fisheries, consisting of black bass, catfish, and an assortment of panfish. Most of California's large population centers are located in water-deficient areas, and reservoirs to be located in these areas will most certainly be used by large numbers of people. It is in situations such as these that we have recorded almost unbelievable use figures—as high as 494 anglers on a one-acre pond at one time.

Our planning activities in water-deficient areas are centered on reservoirs, although an occasional stream appears, usually as a controlled release of surplus water brought into the area. Every effort is made to solve the problems of water level control, access, and development on reservoirs. In a few instances, small warmwater reservoirs—on the order of several hundred surface acres—were included in The California Water Plan as recreation projects. As the planning becomes more detailed we will locat additional sites for recreation reservoirs. Dam and reservoir sites located below conduit routes will be particularly attractive. They can be provided with water from the canal during periods of abundant supply, and maintained at a relatively constant level. We are also evaluating the possibility of developing the recreational potential of the canals.

The things that I have been discussing are largely those on the bright side of our program. We also have our share of problems. One of the most serious is that of placing economic values on recreation. Our recommendations for protecting or enhancing fisheries, wildlife, and recreation resources involve the expenditure of money—often a great deal of money. We support our recommendations in terms of man-days of use, or monetary values based upon gross expenditures by anglers and other recreationists. Engineers, water-users, and economists point out that values based upon gross expenditures are valid and useful expressions of value, but that they are not compatible with the types of values used to evaluate water development projects, since net values are used in the latter case.

The problem is far from resolved yet in California. We are giving it a lot of serious thought though, as I know is being given throughout the country. We strongly desire to have recreation, fish, and wildlife included as project purposes in California's water development program. If recreation is to become a project purpose, it must be reduced to dollar terms so that it can be compared equitably with other project benefits and costs.

By way of summary, let me say that we now have recreation, fish, and wildlife planning units participating in the formulation of plans for the development of California's water resources. We are a part of the team doing the *initial* planning; an area where we have the opportunity to produce the greatest benefit.

Among our accomplishments we can point to planned future projects which include the facilities, operating criteria, etc., for the development of recreation potentials, and to recreation projects already authorized by our State Legislature.

Perhaps more important, we have achieved a level of cooperation where state fish and game, water development, and recreation agencies are beginning to work together, and feel some degree of responsibility for the other agency accomplishing its objectives. The result will almost certainly be a more smoothly functioning water development program, and a better quality of outdoor recreation for future generations.

DISCUSSION

MR. BILL NESS [Knox College, Galesburg, Illinois]: Is there any consideration given towards beauty in some of these plans?

MR. PELGEN: Since we have added our beach and park planners to the program, such consideration has been given. They are quite seriously concerned about the esthetics of the surrounding areas and they evaluate all potentials from a series of criteria they have developed. Unfortunately, most of the reservoirs don't meet the conditions in their criteria.

However, where opportunities exist to increase esthetic values, the opportunities are certainly recommended.

MR. TED B. FORD [Louisiana Wildlife and Fisheries Commission, New Orleans, Louisiana]: You say this has been in consideration with these other projects. Is that on a par level, or is fish and wildlife consideration at the bottom of the ladder?

MR. PELGEN: I believe we can say they are on par value. We have some basic disagreements with the water resources agencies regarding expression of economic values, and they have a method which places much lower values on fish and wildlife than does the Department of Fish and Game. However, the values attributable to fish and wildlife are considered on a par with other economic values.

CHAIRMAN SHIELDS: What are some of the major deficiencies in the biology of the existing reservoirs, which need to be overcome to supply people in your stage-level of planning with enough knowledge to do a good job?

MR. PELGEN: I shall have to give a California standpoint to that answer. The characteristics of rainfall and runoff in the western part of the United States are such that our reservoirs almost always fluctuate a great deal, often through a several-hundred-foot range each year, and we completely lack some very basic knowledge on the biology of fluctuating reservoirs.

If we knew a little bit more about what makes these reservoirs function insofar as fish production is concerned, we would be much closer to success.

CHAIRMAN SHIELDS: From a mid-western standpoint, that is our deficiency and until we learn more of the effect of water level fluctuation on our existing reservoirs, I am afraid fellows like Dave are going to have a tough job to outguess the water planners.

DISCUSSION LEADER TACK: You have alluded to the fact that the water resource people have a different way of evaluating recreational facilities than the fish and wildlife people. I was impressed by the general conservatism of the fish and wildlife people, particularly in the federal survey on this particular matter. I think that we are much too conservative. I presume this is a byproduct of our scientific training. Economists or other engineers planning water resources always give the most beneficial circumstances in establishing a value, so I think maybe we should look along that line also. We are almost certain these values will increase with the years.

DR. J. V. K. WAGAR [Colorado State University, Fort Collins, Colorado]: We have one other way of evaluating these areas which was not mentioned. That was the way that came to light with the recent Echo Park dispute. There, all the financial and engineering facts were on the side of building that dam, but by considering all the esthetics, all the recreational facts, and bringing them to a well-informed public, the public decided not to build the dam even though the engineering and financial facts were there.

DISCUSSION LEADER TACK: With respect to that, I would like to recommend to you Congressman Engle's comments with respect to conservation provisions in water plans. It was in the Congressional Record. I cannot give you the exact citation, but it is well worth reading.

RELATIVE EFFICIENCY AND SELECTIVITY OF GEAR USED IN THE STUDY OF STREAM FISH POPULATIONS

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Knowledge of the relative efficiency and selectivity of the gear used for sampling is necessary for effective planning of fishery investigations and for intelligent interpretation of the results. All gears are selective to some degree. For this reason a variety of gears gives a better indication of the diversity of the fish population than would any one gear. This is desirable, of course. However, the corollary, that each individual gear will show a different species composition, brings complications. The situation is well illustrated by Table 1, which shows the species of fish captured in two collections made in 1948 with three types of gear in a short section of White River, Missouri. In the June collection longear sunfish undoubtedly were important, but did they make up 70, 63 or 55 per cent of the population? Spotted bass obviously were not absent entirely as indicated by the hoop net catch, but did they make up 7 or 17 per cent? The situation only becomes more complicated when additional sampling is done. The September collection showed percentages of longear sunfish varying from 17 to 80 and spotted bass from 0 to 8. Other species showed similarly wide variations.

The problem of determining the true composition of the fish population has many ramifications. The amount of effort used with each type of gear, the skill of the operators, the physical characteristics of

TABLE 1. TOTAL NUMBERS AND SPECIES COMPOSITION (PERCENTAGE) OF FISH COLLECTED WITH THREE GEARS AT THE MIDDLE WHITE RIVER STATION IN JUNE AND SEPTEMBER, 1948

	June 6-9			September 2-10		
Species	Hoop net	Electric seine	Drag seine	Hoop net	Electric seine	Drag seine
Longnose gar			1.4			
Gizzard shad			4.1		2.2	
Highfin carpsucker		4.1			19.8	75.9
Hogsucker				0.7	0.9	
Black redhorse		0.7				
Golden redhorse		2.1	8.2	4.2	5.6	3.4
Channel catfish	1.2	3.4				
Yellow bullhead					0.4	
Flathead catfish	3.7	0.7		1.4	1.3	
Spotted bass		16.6	6.8		8.2	3.4
Smallmouth bass		2.8	9.6		0.4	
Green sunfish		2.1		1.4	0.9	
Longear sunfish	70.4	55.2	63.0	80.0	52.2	17.2
Bluegill sunfish					0.4	
Rock bass	21.0	11.7	4.1	12.7	7.3	
White crappie	3.7	0.7				
Freshwater drum			2.7		0.4	
Total number	81	145	73	142	232	116

the sample area, and the water conditions prevailing when the sampling was done as well as the actual number and kind of fish present, all have their effects on the number and kind of fish caught with a gear. However, to arrive at a reasonable estimate of the composition and abundance of the fish population, we first need to know all we can about the efficiency and selectivity of the gears used to obtain our samples. The purpose of this paper is to develop generalizations concerning the effectiveness of the various types of gear used to sample stream fish populations and to test these generalizations empirically.

The fish populations of Missouri streams have been studied intensively since 1947. At that time three or more stations were located upon each of 10 representative streams of the state. Each station was sampled three times (spring, summer, fall) each year through 1953. Since 1953 a single annual collection has been made at each station. A variety of gear was used in an attempt to minimize gear selectivity and to assure that the sample was representative of the fish population of the sampled area. Gear used included hoop nets, electric seines, and drag seines. Hoop nets were fished unbaited, without wings or leads, and were usually of 1-inch mesh (bar measure). The electric seine was similiar to that described by Funk (1949), although several minor changes were made over the years. The drag seines used were of ¼-inch mesh and usually were at least 100 feet in length.

The material presented here is based upon 242 collections made at 13 stations on four major Missouri streams. A total of 48,257 fish weighing 17,209.5 pounds were collected. These included only those fish weighing one-half ounce or more, thus most forage species and young of other species were not considered. All three gear types were used in making most of the collections. In a few instances, however, one or another of the gears was not used. Included are collections from three stations on the White River made during the period 1947 to 1951, three stations on the Meramec River (1947-1953), and four stations on the Current River (1947-1953). These three rivers are typical of Ozark Highland streams of Missouri. Collections made during the period 1947-1952 from three stations on the Salt River, a prairie stream of northern Missouri, are also included.

This work was financed in part with Federal Aid to Fish Restoration funds under Missouri's Dingell-Johnson Project F-1-R. The common names of fishes used are those recommended in the American Fisheries Society (1948) list as subsequently amended by the Society's Committee on Names of Fishes.

Species lists were prepared for each station and indexes thought to be indicative of the efficiency and selectivity of the gears used were calculated for each gear and species. Table 2 illustrates the method. One index used was frequency of occurrence in the collections made with a particular gear. It was assumed that the higher the percentage of occurrence the more effective the gear was in taking a particular species. This index for a particular species and gear should be directly comparable with a similar index for the same species taken with another gear at the same place. Thus, in terms of frequency of occurrence, drag seines were 1/10 less efficient (89 per cent) and hoop nets ½ less efficient (52 per cent) than the electric seine (100 per cent) in taking smallmouth bass at the Upper Meramec.

TABLE 2. SPECIES TAKEN AT THE UPPER MERAMEC RIVER STATION WITH HOOP NET, ELECTRIC SEINE AND DRAG SEINE BY FREQUENCY OF OCCURRENCE, NUMBER PER UNIT OF EFFORT AND AVERAGE WEIGHT, 1947-1953. IMPORTANT SPECIES ARE INDICATED BY AN ASTERISK (*)

Species	Frequency of occurrence (per cent)			Number per unit effort (1)			Average weight (ounces)		
	Hoop net	Electric seine	Drag seine	Hoop net	Electric seine	Drag seine	Hoop net	Electric seine	Drag seine
Rainbow trout			11			0.7			3.5
White sucker	10	5		tr	0.1		9.5	11.0	
Hog sucker*	43	100	55	0.3	57.4	13.8	11.1	5.3	3.4
Spotted sucker	19	29		0.1	0.9		11.5	11.1	
Black redhorse*	5	90	22	tr	40.5	5.3	8.0	8.1	4.5
Golden redhorse*	67	86	33	0.7	36.5	5.3	12.9	9.5	4.9
Northern redhorse	5	29		tr	0.7		11.0	7.3	
Carp		19			0.5			38.2	
Hornyhead chub	5	29	11	0.1	3.1	0.7	2.2	2.2	0.5
Common shiner	19	33	11	0.3	4.0	0.7	3.3	1.5	1.0
Stoneroller		19			4.9			0.9	
Black bullhead	38	19		0.6	1.2		7.8	6.4	
Yellow bullhead*	95	57		6.2	2.3		5.2	5.1	
Grass pickerel	14	43		0.1	1.4		4.2	2.7	
Logperch		10			0.8			0.7	
Smallmouth bass*	52	100	89	1.0	46.1	12.5	5.8	4.5	1.9
Largemouth bass*	19	67	22	0.1	5.0	7.9	4.1	5.8	1.5
Green sunfish*	90	100	11	7.7	20.9	9.2	2.3	1.9	1.8
Spotted sunfish	14	10		0.1	0.2		2.0	1.0	
Longear sunfish*	100	100	89	48.2	128.2	50.0	1.3	1.1	1.1
Bluegill sunfish	62	33		1.4	2.0		2.0	2.1	
Rock bass*	100	100	11	14.1	25.3	3.9	3.3	3.2	3.2
White crappie	10			0.1			12.3		
Muddler		10			0.8			1.6	
Totals and means				81.3	398.9	132.2	2.4	4.3	3.0
Number of collections	21	21	9						

(1) Hoop net, per 10 net-days; electric seine and drag seine, per 10 gear-hours.
tr Less than 0.1.

The second index computed was the number of fish captured per unit of effort with each type of gear. The units of effort selected were: for the hoop nets, 10 net-days; for the electric seine and drag seine, 10 gear-hours. The chief reason for using these particular units was that they tended to give significant figures without the use of excessive numbers of decimal places. It must be emphasized that units of one gear are in no way comparable with those of another gear. Thus,

TABLE 3. NUMBER OF SPECIES, AVERAGE NUMBER PER UNIT OF EFFORT AND AVERAGE WEIGHT OF FISH TAKEN IN HOOP NETS, ELECTRIC SEINE AND DRAG SEINE AT 13 STREAM STATIONS

Stations (and dates)	Number of species				Number per unit of effort (1)			Average weight (ounces)		
	Total number	Per cent of total								
		Hoop net	Electric seine	Drag seine	Hoop net	Electric seine	Drag seine	Hoop net	Electric seine	Drag seine
Lower Salt (1947-52)	32	53	84	59	6	236	138	20.9	10.5	6.9
Middle Salt (1947-52)	27	52	89	19	11	108	32	22.2	13.3	3.0
Upper Salt (1947-52)	14	86	71	86	70	147	87	4.2	2.2	2.4
Lower White (1947-51)	28	75	71	61	29	230	275	9.9	2.6	2.5
Middle White (1947-51)	26	65	88	73	38	257	271	10.6	4.6	3.0
Upper White (1947-51)	27	70	81	41	45	153	68	3.6	4.6	1.7
Lower Meramec (1947-53)	44	57	89	73	12	166	223	6.2	7.9	3.8
Middle Meramec (1947-53)	43	67	86	65	29	241	303	3.4	6.1	3.2
Upper Meramec (1947-53)	24	79	92	46	81	399	132	2.4	4.3	3.0
Lower Current (1947-53)	46	74	93	35	19	188	91	9.3	4.5	3.4
Middle Current (1947-53)	33	70	88	30	23	143	62	4.1	5.8	3.8
Upper Current (1947-53)	22	82	100	41	117	262	92	3.1	4.0	4.0
Current No. 4 (1947-53)	25		100	44		330	609		8.2	9.5
Medians		70	88	46	29	230	132	4.2	4.6	3.2
Ranges		52-86	71-100	19-86	6-117	108-399	32-609	2.4-22.2	2.2-13.3	1.9-9.5

(1) Hoop net, per 10 net-days; electric seine and drag seine, per 10 gear-hours.

when green sunfish at the Upper Meramec were caught at the rate of 21 per electric-seine-unit and 9 per drag-seine-unit, it is not indicated that the electric seine was twice as efficient as the drag seine. Since the catch per unit of effort by the gears studied are not comparable, a statistical analysis of efficiency, such as was so ably done by Starrett and Barnickol (1955) on commercial fishing gear on the Mississippi River, was not possible.

The two indexes, frequency of occurrence and number per unit effort, indicate in somewhat different ways the efficiency with which a species is captured with a gear. They, therefore, also measure the relative efficiency of the gear in capturing the various species in the population; in other words, the species selectivity of the gear. The value of these factors as measures of efficiency is limited by the fact that both are influenced by the abundance of a species. Thus, a very abundant species such as the longear sunfish at the Upper Meramec (Table 2) may show high percentages of occurrence for all gears. If fish are abundant enough even inefficient gears will capture some of them. The number per unit of effort frequently is used as a measure of abundance, which, of course, it is in a relative sense when the same gear is fished in the same water. However, as will be shown later, a species may be captured with a gear at greatly different rates at different times or places. This fact will be used to help indicate the efficiency of the gear.

The third index determined was the average weight of each species caught by each gear. This was used as a crude measure of the size selectivity of the various gears. In some instances it is probably adequate. In others, statistical methods similar to those employed by Starrett and Barnickol (1955) would be needed to demonstrate the significance of any differences which may exist.

The total number of all fish per unit of effort and the average weight of all fish captured with each gear were computed for each station.

The results for the individual stations are summarized in Table 3. They indicate that at 11 of the 13 stations the electric seine took a larger percentage of the species recorded for the station than any other gear. At another station (Upper Salt) the electric seine was used for only 3 of 17 collections, too little to give it a reasonable test. The median value for the electric seine was higher than for the other gears. The number-per-unit-effort data suggest that fish were captured with the electric seine more consistently than with the other gears. This is based upon the fact that the range for the electric seine was least and the median value was nearer the center of the range. It frequently has been observed that the fish taken in hoopnets tend to be large, the average weight of those captured with the electric seine tends to be intermediate and those taken with the drag seine, small. Mesh size would explain differences in the size of fish caught with the hoopnet and with the drag seine but the fact that the average weight of fish taken with the electric seine is intermediate is of particular interest. In the station data presented in this table the phenomenon is evident for only five of the 12 stations where all three gears were used. Both the maximum and the minimum values show it although the medians do not. It is possible that the phenomenon is dependent upon the species involved.

Gear efficiency and selectivity have little meaning except in terms of the species of fish captured. In order to develop information regarding the effect on individual species, frequency of occurrence, number per unit of effort and average weight were tabulated for all the stations where a species was important. Median values were then determined. The median, rather than the mean or some other expression of central tendency, was used because it was easy to determine, would always be on or near an empirical value and probably would serve the purpose as well as any other such expression. The tabulation for green sunfish (Table 4) will serve to illustrate the method.

TABLE 4. FREQUENCY OF OCCURRENCE, NUMBER PER UNIT OF EFFORT AND AVERAGE WEIGHT OF GREEN SUNFISH TAKEN WITH HOOP NETS, ELECTRIC SEINE AND DRAG SEINE AT STATIONS WHERE IT WAS AN IMPORTANT SPECIES

	Frequency of occurrence (per cent)			Number per unit effort (1)			Average weight (ounces)		
Stations (11)	Hoop net	Electric seine	Drag seine	Hoop net	Electric seine	Drag seine	Hoop net	Electric seine	Drag seine
Lower Salt	12	59	16	0.1	1.5	0.7	3.1	0.9	1.0
Middle Salt	25	65	0	0.2	4.3	0.0	1.6	1.6	
Upper Salt	92	100	81	8.5	33.7	23.6	1.4	1.3	0.8
Lower White	67	92	8	0.5	21.6	0.3	3.4	1.9	6.0
Middle White	36	85	8	0.7	2.7	0.4	2.6	2.8	3.0
Upper White	67	64	18	1.7	3.3	1.1	2.4	1.2	0.8
Middle Meramec	68	43	6	0.8	5.7	0.3	2.1	1.3	0.5
Upper Meramec	90	100	11	7.7	20.9	9.2	2.3	1.9	1.8
Lower Current	35	85	18	0.2	8.5	7.2	2.5	2.0	1.9
Upper Current	58	52	8	0.7	2.8	5.9	2.8	2.1	1.5
Current No. 4		95	0		8.4	0.0		1.3	
Median	63	85	8	0.7	5.7	1.1	2.5	1.6	1.5

(1) Hoop net, per 10 net-days; electric seine and drag seine, per 10 gear-hours.

The term "important species" requires some clarification. Species were assigned to this category only if they met quantitative criteria based upon the frequency of occurrence of the species at a station and the relationship of the total number and weight of the species to the number and weight of all fish taken at the station. The derivation and testing of these criteria is the subject of another report (Funk, 1956).

Only data for stations at which the species was rated "important" were used for the present analysis, in an attempt to minimize the effects of varying abundance upon the factors being used to measure efficiency. This attempt was only partially successful, however. An "important species" was at least moderately abundant at all stations where it was so rated but it was not equally abundant at all.

The median values for 19 species were tabulated in Table 5. Only species rated as "important" at three or more stations were included in the tabulation.

In terms of frequency of occurrence the electric seine was the most effective collecting device for 15 of the 19 species. Yellow bullheads, flathead catfish, longear sunfish and rock bass were captured most frequently with hoop nets. The median percentage of occurrence for 11 of the 19 species was lowest in the drag seine and for 8 species was

TABLE 5. MEDIAN VALUES OF FREQUENCY OF OCCURRENCE, NUMBER PER UNIT OF EFFORT AND AVERAGE WEIGHT FOR 19 SPECIES OF FISH TAKEN WITH HOOP NET, ELECTRIC SEINE AND DRAG SEINE. ONLY SPECIES IMPORTANT AT 3 OR MORE STATIONS ARE INCLUDED

	Frequency of occurrence (per cent)			Number per unit effort (1)			Average weight (ounces)		
Species (and number of stations)	Hoop net	Electric seine	Drag seine	Hoop net	Electric seine	Drag seine	Hoop net	Electric seine	Drag seine
Longnose gar (3)	14	71	63	0.2	2.4	10.7	15.3	13.4	10.8
Gizzard shad (6)	11	65	53	0.1	15.1	21.8	3.5	6.2	6.8
Smallmouth buffalo (3)	38	47	28	0.2	1.1	2.7	39.8	31.6	21.5
River carpsucker (4)	53	100	75	1.2	41.5	19.3	13.7	10.2	6.8
Hog sucker (10)	15	73	42	0.1	16.5	7.4	20.0	7.5	3.8
Black redhorse (9)	29	62	22	0.4	23.5	5.3	13.7	8.1	4.5
Golden redhorse (9)	43	67	36	0.5	14.3	5.2	17.5	8.3	4.2
Northern redhorse (3)	13	79	22	0.1	4.6	2.9	12.3	9.2	5.9
Carp (6)	27	51	13	0.5	4.1	0.5	46.1	23.9	42.6
Channel catfish (8)	47	68	24	1.4	9.6	5.0	10.6	9.3	3.2
Yellow bullhead (3)	95	50	0	6.2	2.1	0.0	6.1	5.6	0.0
Flathead catfish (8)	62	36	12	0.7	1.2	1.7	59.6	25.1	7.6
Spotted bass (3)	10	65	52	tr.	14.1	11.7	10.5	6.1	2.6
Smallmouth bass (9)	42	80	62	0.3	9.5	19.9	8.2	3.8	1.9
Green sunfish (11)	63	85	8	0.7	5.7	1.1	2.5	1.6	1.5
Longear sunfish (9)	95	63	55	19.6	65.0	42.5	1.3	1.1	1.1
Bluegill sunfish (3)	36	60	15	0.7	5.5	2.1	2.9	1.2	3.2
Rock bass (8)	98	94	12	10.2	21.5	3.4	4.2	3.2	3.2
Freshwater drum (3)	53	100	68	0.7	14.6	23.8	10.9	7.3	4.8

Highest; Lowest — Upper third; Lower third — High, Moderate, Low

(1) Hoop nets, per 10 net-days; electric seine and drag seine, per 10 gear-hours.
tr. Less than 0.1.

lowest in the hoop net. The relative standing of the three gears was as follows: In the electric seine catch 15 species had their highest percentage of occurrence; 4 species were intermediate. In the hoop net catch 4 species were highest, 7 intermediate and 8 lowest. In the drag seine 8 species were intermediate and 11 species had their lowest median percentage of occurrence.

As was pointed out earlier, the number per unit effort data for the different gears can not be compared directly. Also, when a species is unusually abundant it may be caught in large numbers with a gear which normally would not capture it efficiently. In an effort to differentiate between the effectiveness of a gear and the abundance of a species, the number per unit effort data for each gear was divided into high, middle, and low thirds. In Table 5 the high thirds are underlined twice, the low thirds underlined once, while the middle thirds are not underlined. The data were then analyzed in accordance with the following assumptions regarding the various possible combinations:

1. All gears in low third. Abundance relatively low, no test for efficiency possible.

2. Two gears in low third, other middle or high. Abundance relatively low, highest gear effective in taking the species, no test for others.

3. One gear in lower third, others middle or high. Species abundant, lowest gear not effective in taking the species.

4. All gears in middle third. Species moderately abundant, no test for efficiency possible.

5. One gear in upper third, others middle or low. Species abundant, highest gear effective.

6. One gear in upper third, one in middle, one in lower. Species abundant, gears ranked as very effective, effective, not effective.

7. Two gears in upper third, other middle or low. Species abundant, lowest gear not effective, no test for others.

8. All gears in upper third. Species very abundant, no test for efficiency possible.

9. One gear took no fish, others in any third. Abundance variable, gear taking no fish not effective.

In applying these assumptions to the data for the longnose gar we have the hoop net and electric seine catch rates in the lower third, the drag seine in the middle third. Therefore, we can assume the drag seine was the most effective of the three gears in capturing the species. However, the frequency of occurrence data showed that longnose gars were most frequently taken with the electric seine, although the percentage for the drag seine was also high. Apparently both of these gears were effective in capturing the species but the hoop net was not especially effective.

The gizzard shad catch rates with electric seine and drag seine each were in the upper third but the hoop net rates were in the lower third. Therefore, we can assume that hoop nets did not take the species efficiently and that this method does not indicate any difference in efficiency between the electric seine and drag seine. In terms of frequency of occurrence, the electric seine percentage was highest, the drag seine intermediate and the hoop net low. Apparently the efficiency of the three gears can be ranked in this order.

The rates for smallmouth buffalo for all gears were in the lower thirds, indicating low abundance of the species and no test of efficiency by this method. In terms of frequency of occurrence the electric seine was most efficient and the drag seine least efficient.

River carpsucker catch rates were in the upper thirds for all gears. This indicated that the species was very abundant and that no test for efficiency of the gears could be made by this method. The electric seine was most efficient and the hoop net least efficient in terms of frequency of occurrence.

A test for efficiency of all of the gears in taking hog suckers was possible since the rate for each gear was in a different third. The electric seine rate was in the upper third so this gear was rated as very effective in taking the species. Drag seines, in the middle third, ranked as effective and hoop nets, in the lower third, as not effective. The frequency of occurrence values shows the same relationship between the gears.

The electric seine was the most effective gear for taking black redhorse by the number-per-unit-effort data. No distinction could be made between the other two gears. In terms of frequency of occurrence the electric seine was most effective and the drag seine least effective. For golden redhorse the number-per-unit-effort information permitted no test; values for all gears were in the same (middle) third. Frequency of occurrence values indicated the electric seine was most effective and the drag seine least effective in taking the species. In contrast to the two preceding related species, the catch-rate data for the northern redhorse indicated that the drag seine was the most effective method of capture, with no distinction between the other two gears. The percentage of occurrence of northern redhorse was highest for the electric seine, however, and lowest for the hoop net. Both electric seine and drag seine apparently were effective in taking the species.

The hoop net was effective in taking carp according to the catch rate information but no distinction could be made between the other two gears. According to the occurrence data the electric seine was most effective and the drag seine least. Apparently the hoop net and electric seine were about equally effective in taking the species.

For the three catfish species (channel catfish, yellow bullhead and flathead catfish) the hoop net was very effective gear, according to the catch-rate information. No comparison between the other two gears was possible by this method for channel catfish and flathead catfish but the drag seine was ineffective for capturing yellow bullheads. The frequency of occurrence data show channel catfish taken most frequently with the electric seine but yellow bullhead and flathead catfish most frequently captured in the hoop net. No bullheads were taken with the drag seine and the gear was least effective for the other two species.

The drag seine was a very effective gear for taking spotted bass and smallmouth bass in terms of number per unit effort. The hoop net was ineffective for spotted bass but no distinction between the hoop nets and electric seine was possible for the smallmouth bass. Both species were taken most frequently with the electric seine and least frequently with the hoop net according to the occurrence data. Apparently both drag seine and electric seine were effective methods of capture.

Comparison of the catch rates showed that the drag seine was ineffective for capturing green sunfish. No distinction could be made between the electric seine and hoop net. The frequency of occurrence of green sunfish was highest in the electric seine, relatively high in the hoop net, but very low in the drag seine.

The catch rates permitted no evaluation of the efficiency of the gears in taking longear sunfish due to the great abundance of the species. By frequency of occurrence, the percentage for the hoop net was highest but the electric seine value was only slightly less. There probably was little difference in the effectiveness of these two gears. The drag seine was considerably less effective than the other two.

Bluegill catch rates indicated that the drag seine was not effective in taking the species. No distinction could be made between the other two gears on the basis of number per unit effort. By frequency of occurrence the electric seine was most effective and the drag seine least effective.

The drag seine was not effective in taking rock bass according to the catch-per-unit-effort data but no distinction could be made between the other two gears on this basis. The percentage of occurrence of rock bass was highest in the hoop nets but the value for the electric seine was only slightly less. The two gears were about equally effective in capturing the species.

The catch rate data for freshwater drum indicated that the drag seine was a very effective gear for the species. Drum occurred in 100 per cent of the electric seine collections at stations where it was important, however, so both methods may be considered effective for this species.

Since the two indexes (frequency of occurrence, and number per unit of effort,) measure two different facets of the efficiency of a gear, complete agreement of the results is not to be expected. However, in two (hog sucker, yellow bullhead) of the three instances where all three gears were ranked by both criteria, there was complete agreement. In the third instance (spotted bass) there was agreement on the low-ranking gear but the values for the other two were transposed. Of the 21 rankings by the catch-per-unit-effort method, 13 agreed with the corresponding ranking by frequency of occurrence.

Thirteen of the 19 species showed median average weights which were progressively smaller for hoop net, electric seine, and drag seine (indicated by a double underline in Table 5). The median value for the flathead catfish showed this phenomenon although it was evident in the data from only three of the eight stations where the species was important. However, at four of the stations no flathead catfish were taken with the drag seine so the comparison could be made only at the other four. The phenomenon was evident in the median value for the river carpsucker but only one of the four station averages showed it. The data probably are inadequate for this species.

Six species showed median average weights which did not decrease progressively for hoop net, electric seine, and drag seine. For two, the gizzard shad and the yellow bullhead, this may be due to the fact that few or none were taken with one or another of the gears so that little comparative data was available. For the three centrarchids, longear sunfish, bluegill sunfish, and rock bass, the phenomenon is believed to be obscured by the relatively small range in size of the species. There is little opportunity for the size selectivity of a gear to become apparent in a species which reaches near maximum size at six or seven inches. The situation with carp is somewhat related. Very few small carp were taken in these streams with any type of gear. Most of the carp available for capture were so large that size selectivity apparently did not operate.

It is apparent then that the catch of the ¼-inch mesh drag seine was dominated by relatively small individuals of most species, that 1-inch mesh hoop nets tended to catch relatively large individuals, and that the size of the fish caught with the electric seine tended to be intermediate between these two extremes.

In summary, it would appear that under the conditions described here, the following statements concerning the species selectivity of the three gears were true. The electric seine was most effective in capturing hog suckers, black redhorse, gizzard shad, smallmouth buffalo, river carpsucker, golden redhorse, green sunfish and bluegill sunfish in these Missouri streams. Yellow bullheads and flathead catfish were captured most effectively in hoop nets. The hoop net and electric seine were about equally effective in capturing carp, channel catfish, rock bass and longear sunfish. The electric seine and drag seine were about equally effective in taking longnose gar, northern redhorse, spotted bass, smallmouth bass and freshwater drum. The electric seine was less effective than the hoop net in taking yellow bullheads and flathead catfish. The hoop net was least effective in capturing gizzard shad, hog suckers, spotted bass, longnose gar, river carpsucker, northern redhorse, smallmouth bass, and freshwater drum. The drag seine was least effective in taking yellow bullheads, green sunfish, bluegill sunfish, rock bass, smallmouth buffalo, black redhorse, golden redhorse, carp, channel catfish, flathead catfish, and longear sunfish.

Size selectivity was evident from the fact that the average weight of most species taken in the drag seine was relatively low; in the hoop net, relatively high; and with the electric seine, intermediate. Carp and three small centrarchid species did not exhibit this phenomenon, possibly because of the restricted range of sizes available for capture.

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DISCUSSION

MR. DIETER RODRIAN [Canokin Nature League, Caseyville, Illinois] When you talk about the efficiency, was the actual cost of operating all these things taken into consideration?

MR. FUNK: No, I have to admit that it was not. The efficiency I am talking about here is that of the gear in taking fish. The cost of operating I did not consider. However, it would be approximately the same for all three, since the main cost would be the salaries of the people employed to operate them and each would take about the same number of men. The initial cost of the gear would be a different matter, but that would be spread over quite a fair length of time so it wouldn't be a big factor either.

DISCUSSION LEADER TACK: Has the relationship to the distribution of different habitat types such as pools, riffles, etc., been incorporated in evaluating this gear?

MR. FUNK: That is a very pertinent point, and one which needs to be considered in selecting a gear type. For example, any of you who have done any seining, know you must use a drag seine in an area that is pretty free of cover. Whereas, an electric shocker of any of the different kinds that are used can be used effectively in good cover. That is the main reason it is more effective gear for this purpose. You can operate it in cover where the fish are and not out in the open where the chances of catching fish are less.

SMALLMOUTH BASS MANAGEMENT IN THE POTOMAC RIVER BASIN

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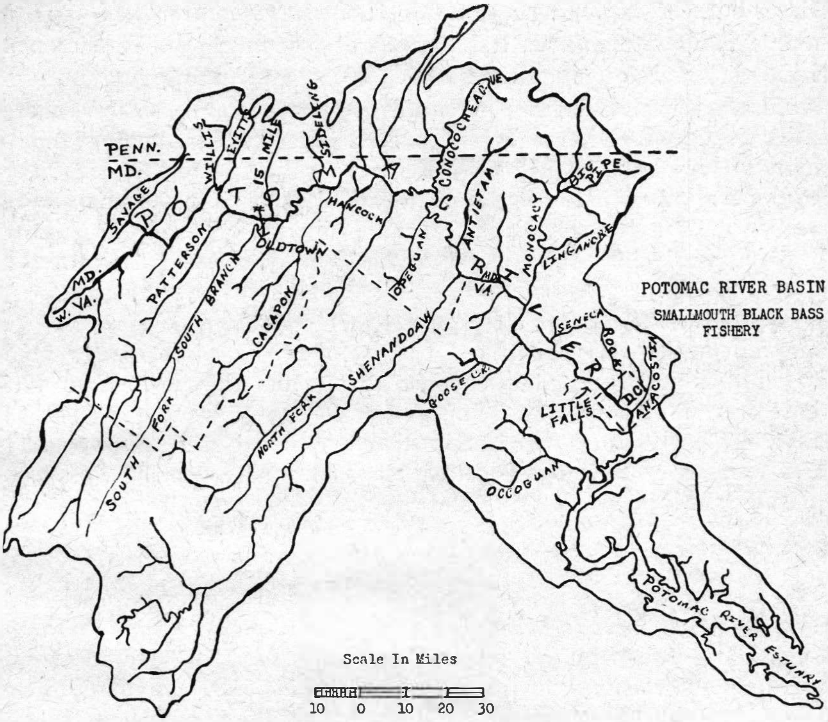
Management of the Potomac River Fishery was initiated in 1955 as a Federal Aid to Fisheries program. To provide data for this management, research was undertaken to determine the standing population of smallmouth and associated species in sectors of the river basin, their age and growth rates, spawning characteristics of smallmouth and the impact of sport fishery on the smallmouth population. A map of the Potomac and its tributaries is shown in Figure 1.

Smallmouth black bass, *Micropterus dolomieu*, were first introduced into the Potomac River from the Ohio River in 1853. The smallmouth population expanded rapidly and soon enjoyed wide distribution in the main stream and tributaries.

The Potomac fishery is now second only to that of the Susquehanna River in fishing pressure and anglers' success in Maryland waters (Elser, 1955). At present the Potomac smallmouth fishery extends from Little Falls in Montgomery County, near our nation's capital, to Old Town in Allegany County, a distance of approximately 170 miles. The river over this area covers about 14,000 acres or a body of water 3.5 times the size of Deep Creek Lake, Maryland's largest impoundment (Barry, 1954). It is estimated that 51,000 anglers in 1955 bought licenses to fish in the Maryland portion of the river basin. The number of fishing trips per year from principal landings has more than doubled since 1946. However, inaccessibility results in a lower fishing pressure over much of the extreme upper and lower parts of the river. There are few access roads and boat landings. Moreover, approaches to the river shore are difficult because of steep and rocky

[1] In the absence of the author, this paper was read by Mr. Edwin M. Barry.



embankments. Angling is carried on from canoes, pole boats and small outboard runabouts. Bank fishing and wading are productive in summer. The advent of spinning tackle with effective small lures has improved the catch of smallmouth under clear water conditions.

Population Sampling Methods

Electrofishing apparatus were the most successful type gear employed in estimating fish populations. For river sampling a portable Homelite 115-230 volt alternating current generator equipped with a voltage regulator was placed in a 14-foot aluminum flat bottom skiff. Three types of electrodes were used. The first of these was the conventional electric seine 50 feet in length operated by a crew of six men. A second type of electrode consisted of a 50-foot length of No. 12 seven strand flexible copper wire floated at the surface at five-foot intervals by styrofoam plastic seine floats. The third electrode system, also 50 feet in length, was composed of alternate polarity vertical droppers six feet in length which could be spaced two to five feet apart.

Direct current exploying a 230-volt Homelite generator was used to sample shallow tributaries less than three feet in depth. In the open river, with water temperatures above 50°F. alternating current produced a better shocking effect than direct current and fish were more easily retrieved. Direct current proved successful in smaller tributaries at temperatures below 50°F. In sampling sectors of the river for population estimates by the mark and recapture method nets were used to delimit the selected riffle and pool areas. Fish captured by electrofishing were either tagged or fin clipped, released and allowed several hours for redistribution before the site was shocked again.

Haul seines 25 feet by 4 feet of 1-4 inch stretch mesh were used to sample young-of-the-year fishes. The use of larger seines is prevented by boulders and rock ledges common throughout the river. Fast currents prevent effective haul seining of adult fishes. Double funnel fish traps six feet long by two feet in diameter of one-inch mesh poultry wire were set to collect channel catfish, yellowbelly sunfish, rock bass and black crappie for tagging and age and growth studies.

RIVER POPULATIONS

Five areas characteristic of pools and riffles in the river were selected for population analysis by electrofishing. Four thousand one hundred seventy-two fish with an aggregate weight of 1,737 pounds were weighed and measured during the summer of 1955. By numbers, game fish or desirable species formed 52.2 per cent of the populations; rough fish, or less desirable species, 47.8 per cent. Smallmouth, *Micropterus dolomieu,* led in numbers of game fish with an average of 13.7 per cent for the areas sampled. Sixty-four per cent of the smallmouths captured by electrofishing were between 7.0 and 9.9 inches. Nineteen per cent were 10 inches (minimum legal size) or longer. Smallmouth captured measured from 2.5 inches total length to 18.9 inches. Yellowbelly sunfish, *Lepomis auritus,* were second in number collected, comprising 13.3 per cent of the population. Channel catfish *Ictalurus lacustris,* formed 5.2 per cent; bluegill, *Lepomis machrochirus,* 4.0 per cent; rock bass, *Ambloplites rupestris,* 3.5 per cent; fallfish, *Semotilus corporalis,* 2.8 per cent; green sunfish, *Lepomis cyanellus,* 2.8 per cent; pumpkinseed, *Lepomis gibbosus,* 2.4 per cent; blue catfish, *Ictalurus furcatus,* 1.9 per cent; largemouth black bass, *Micropterus salmoides,* 1.0 per cent; yellow bullheads, *Ameiurus natalis,* 1.0 per cent; black crappie, *Pomoxis nigro-maculatus,* 0.3 per cent; and brown bullheads, *Ameiurus nebulosus,* 0.3 per cent. Hog suckers, *Hypentelium nigricans,* were the most numerous rough fish forming 10.2 per cent of the total population. Redhorse suckers, *Moxostoma macrolepidotum,* and white suckers, *Catostomus commersonii,* formed 7.6 per cent and 7.5 per cent respectively. Creek chubs, *Semotilus atromaculatus,* formed 6.1 per cent and miscellaneous species, including eels, *Anquilla bostoniensis;* Carp, *Cyprinus carpio,* and forage species composed 16.4 per cent. By weight, gamefish or desirable species formed 39.9 per cent and roughfish or less desirable species 60.1 per cent. Smallmouth accounted for 8.2 per cent of the populations sampled (game and rough fish); channel catfish 9.8 per cent; blue catfish 9.0 per cent; yellowbelly sunfish 4.2 per cent; fallfish 1.8 per cent; bluegill 1.5 per cent; rock bass 1.2 per cent; largemouth black bass, 1.1 per cent; and yellow bullheads 1.0 per cent. Green sunfish, pumpkinseed, brown bullhead and black crappie each formed less than 1.0 per cent of the population by weight. Redhorse suckers, the principal rough fish, formed 28.9 per cent of the population. White suckers and hog suckers formed 11.6 and 9.8 per cent respectively. Carp formed 7.0 per cent. Creek chubs and miscellaneous species formed 2.8 per cent of the weight.

SPAWNING OF SMALLMOUTH

Observations on the locations of bass spawning redds in the river and tributaries were conducted in April, May and June of 1955, 1956 and 1957. Successful spawning with hatching of fry was recorded in the twelve tributaries investigated during the three sesaons. In 1956 and 1957 successful spawning and hatching were also recorded in the river proper in Montgomery, Frederick, Washington and Allegany counties. Location of the spawning areas during the survey was made by visual observations using 6x30 power, coated lens binoculars. To determine the number of fry produced on smallmouth redds, fry were taken from nests in the Monocacy River, a major tributary, by means of a suction hose inserted through the bottom of a ten-quart bucket. Fry were transferred to a white enamel pan containing clear water and photographed with a Graflex camera. Enlargements were made in order to count the numbers of fry. The number of fry for five nests examined varied from 455 to 1,438 with an average of 765 fry. The spawning season for smallmouth was determined for the years 1955, 1956 and 1957 by analysis of 243 ovaries of fish collected by electroseining in the Potomac River and its tributaries. Lengths of fish examined were from 96 to 377 millimeters (total lengths) and weights from 13 to 652 grams (less stomachs and contents). Some smallmouth from the same pool showed different degrees of ovarian development when collected on the same date during May, revealing individual differences in spawning time. The trend of spawning by the population was measured by plotting the average ovary weight as the per cent

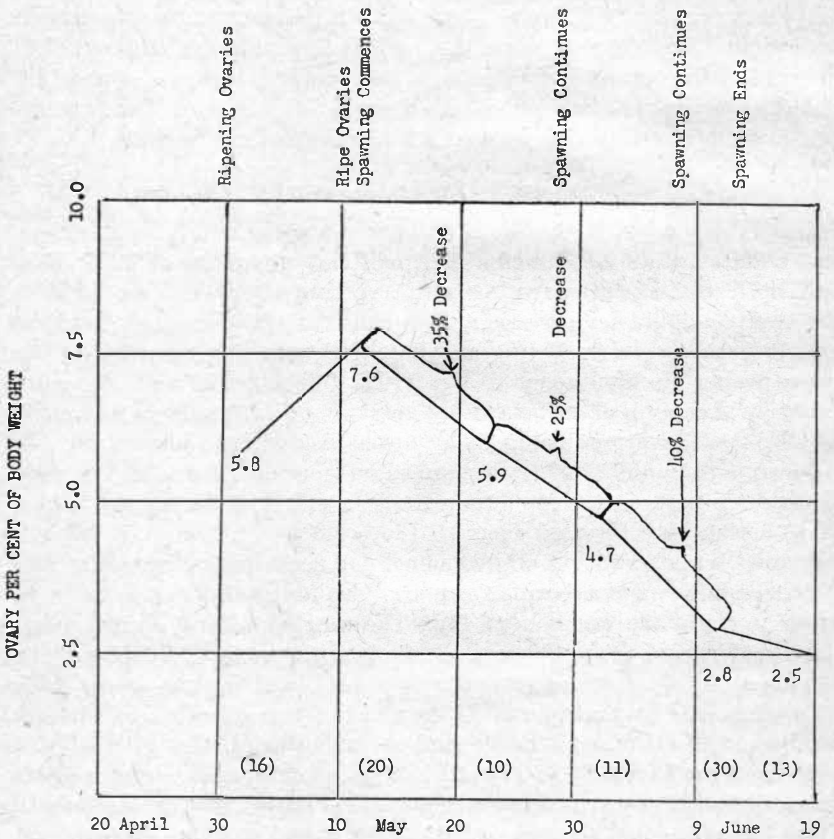
OVARY PER CENT OF BODY WEIGHT

1956

10 Day Averages

Sample 100 Fish

Numbers in parentheses are the samples used to compute averages.



of body weight for samples collected within consecutive ten-day periods at the midpoint of each period. When the ovary per cent of body weight for mature fish decreased to 3.1 or less spawning was completed. This observation is based upon the absence of ripe eggs or presence of a few ripe eggs which would be reabsorbed and not spawned. Spawning in 1955 and 1957 was initiated in May and completed about June 10. Figure 2 demonstrates the reduction in the average ratio of ovary to body weight which occurred during the 1956 spawning season. The first ten-day period from April 27 to May 7 was the period of final ripening of the gonad with an increase of 1.8 per cent in the ovary per cent of body weight. The second 10-day period shows a peak in the ovary per cent of body weight to 7.6. During this period spawning began with a resulting decrease in the weight of the ovary during the following 10-day period. From this high percentage spawning continued until the fifth 10-day period which average is based on fish collected from June 6 to 16. The last period (six days) showed an average decrease of only 0.3 per cent in the ovary per cent of body weight. This slight change is due to the atrophy of post spawning gonadal tissue and is not attributed to spawning of ripe eggs. Evidence of a protracted spawning period is revealed by the continuous decrease in ovary per cent of body weight beginning in the second 10-day period and continuing through the third and fourth periods, rather than an abrupt approach to the low percentage reached during the last period. A check for spawning in June was made by analysis of the ovary per cent of body weight. Ovaries examined in June 1955 averaged 2.1 per cent of the body weight, in 1956 2.9 per cent and in 1957 2.4 per cent. These percentages are characteristic of spent gonads. No ripe gonads were found in June 1955 and 1957. Two ripe gonads were recorded in the first week of June 1956. The later spawning in 1956 is attributed in part to the lower water temperatures prevailing during the spawning season. The average monthly water temperature for April was 58°F. in 1955, 49°F. in 1956 and 56°F. in 1957. For the months of April and May combined the average water temperatures were 63° in 1955, 56° in 1956 and 62°F. in 1957. Elser (1954) reported a similar lag in spawning time which developed as a result of unusually low water temperatures in 1954. Webster (1954) reported that spawning of smallmouth of the main basin of Cayuga Lake is not completed until mid July or later with a spawning threshold of 60°F. or above. However, spawning of smallmouth over the northern shoals in Cayuga with water temperatures resembling those of the Potomac is completed by June.

Breder (1936) reviewed the literature on smallmouth spawning and found 60°F. to 64°F. the threshold temperature at which spawning commences.

Correlating ovary development with age it was found that all roe fish in Age-Group I (4.0 inches) were immature. In Age-Group II (7.7 inches) 75 per cent of the ovaries were mature and in Age-Group III (9.7 inches) 97 per cent of the ovaries were mature. Records of water temperatures, stream flows and turbidities suggest that water temperature is a greater determinant of time of spawning than the other physical phenomena measured.

GROWTH RATES OF SMALLMOUTH AND ASSOCIATED SPECIES

Table 1 lists the calculated total length in inches at the time of annulus formation for smallmouth and associated species. Determination of the age and growth rates for all species except channel catfish and brown bullheads was made by standard scale analysis procedure, projecting the scale image on a white cardboard screen. Back calculations were made by means of a nomograph. Growth rates for channel catfish and brown bullheads were computed from projected images of polished cross-sections of pectoral spines cemented to cellulose acetate slides. Considerable variation in growth rates for smallmouth and associated species was noted for different sectors of the river basin. Surber and Seaman (1949) have shown differences in rate of growth for smallmouth sampled from the South Branch of the Potomac, the Shenandoah and Cacapon Rivers, which are West Virginia tributaries. Growth of Potomac River smallmouth is faster than that of tributary smallmouth. River smallmouth enter the fishery in the second or third growing season with the present minimum legal size of 9.0 inches total length. Most tributary smallmouth enter the fishery in the fourth growing season with some fish entering in the fifth season. River smallmouth show excellent condition factors throughout the year, especially in autumn when large fat deposits around the viscera are in evidence. Tributary smallmouths are less robust and show only fair condition factors when compared to river fish. The growth rate and condition factor for tributary smallmouth is correlated with the density of the rock bass and yellowbelly sunfish populations. Israel Creek in Frederick County has a low density of rock bass and yellowbelly sunfish. In this creek smallmouth show better growth and condition factors than those in Bennett Creek, an ecologically similar stream 21 miles distant which has a disproportionately higher population of rock bass and yellowbelly sunfish. This correlation appeared in seven other tributaries sampled. Surber and Seaman (1949) associate increasing numbers of

TABLE 1. AVERAGE GROWTH RATES OF SOME POTOMAC RIVER BASIN FISHES

Species	Area	Calculated total lengths in inches at annulus formation					
		I	II	III	IV	V	VI
Smallmouth	Potomac River, Allegany Co.	3.9	7.6	9.6	11.2	13.2	14.7
Smallmouth	Potomac River, Frederick Co.	4.2	7.4	9.8	11.6	13.1	15.2
Smallmouth	Bennett Creek, Montgomery Co.	2.3	5.4	8.1	8.5	9.4	
Smallmouth	Catoctin Creek, Frederick Co.	3.0	6.8	8.9	11.1	13.4	
Smallmouth	Israel Creek, Frederick Co.	2.9	6.6	9.2	11.3		
Largemouth	Potomac River, Montgomery Co.	4.9	7.6	9.9	11.8	13.8	15.2
Black crappie	Potomac River, Montgomery Co.	3.7	5.8	7.8	8.8		
Bluegill	Potomac River, Montgomery Co.	2.2	4.1	4.8	5.8		
Channel catfish	Potomac River	7.7	10.5	13.0	15.7	18.1	20.5
Brown bullhead	Monocacy River	5.8	8.0	9.4			
Rock bass	Potomac River	1.9	4.1	5.6	6.4	7.6.	8.4
Yellowbelly sunfish	Potomac River, Frederick Co.	2.9	5.0	5.9			
Yellowbelly sunfish	Potomac River, Frederick Co.	2.6	4.5	5.4			
Redhorse sucker	Potomac River, Frederick Co.	3.4	10.0	14.9	17.3		

rock bass and yellowbelly sunfish with a declining smallmouth population in West Virginia streams.

The river environment is productive smallmouth habitat. Total hardness of river water in Montgomery County is about 125 milligrams of dissolved solids per liter including 28 mg. calcium and 72 mg. bicarbonate. PH at sample stations ranges from 6.8 to 7.9. Griffith (1956) has determined that phytoplankton are more abundant in the river than in tributaries and that phytoplankton are utilized by forage fishes (*Notropis* sp.) in fall and winter to temperatures as low as 40° F., thus providing growth of food organisms while smallmouth are dormant. About 18 per cent of the river consists of food producing riffles with gravel bottoms furnishing an abundance of mayflies, Ephemeridia; stoneflies, Plecoptera; caddisflies, Trichoptera; the helgrammite larva of the dobson fly, *Corydalus cornutus* and crayfish, *Gambarus* sp. Forage fishes including satinfin shiners, *Notropis analostanus;* rosy face shiners, *Notropis rubellus;* and bluntnose minnows, *Hyborhynchus notatus,* are abundant. Excellent cover for smallmouth and forage species is furnished by submerged ledges, boulders, undercut banks and overhanging trees.

In some of the backwaters and deeper, less rapid stretches of the river largemouth black bass, black crappie, bluegill and brown bullhead are increasing in number and supplementing the smallmouth population. These species prefer a subhabitat where few smallmouths are naturally found and for this reason are believed to be a valuable addition to the total fishery. Table 1 lists the average growth rate for these species. Channel catfish are frequently found in smallmouth habitat, but adequate growth rates and desirable condition factors for both species would imply that competition for the amounts of specific food organisms available is not serious (Table 1).

Industrial pollution and domestic sewage at present do not materially affect the production of smallmouth bass food organisms or the distribution of smallmouth in the areas surveyed from the District of Columbia line to Old Town, Allegany County. The Interstate Commission on the Potomac River Basin has embarked on a progressive program for control and elimination of pollution in the metropolitan Washington, D. C., environs and in the upper river basin in Allegany and Garrett counties (Frank, 1957), (Fuhrman, 1954), (Fisher, 1954), (Lull and Marquis, 1957), (Tisdale, 1956 and 1957). Pollution abatement will result in an increase in the distribution and growth of smallmouth and other species. Van Meter (1955) has described the recovery of the Shenandoah smallmouth fishery as a result of elimination of toxic industrial wastes.

CREEL CENSUS

A creel census to determine the harvest of Potomac River fishes was conducted for a 200-acre sector at Lander in Frederick County from June 1, 1956, the opening date for bass fishing, Maryland, to September 30th, 1956, in an area where fish population estimates were made before, during and after the creel census period. The Lander sector was chosen because it represents one of the areas of heavy fishing pressure in the river basin. In conformity with the recommendations of Best and Boles (1956) the creel census calendar was stratified with modifications to include all Saturdays, Sundays and holidays. Fishing pressure curves for each day of the week were developed to enable factoring of creel census data for days when census was not made. Results of the 1956 creel census are based upon interviews with 1,344 anglers who fished 7,944 hours and creeled 2,851 fish of all species, for a creel rate of 0.36 fish per man hour. Including fish returned, the total catch was 7,024 for a catch rate of 0.88 fish per man hour.

Smallmouth formed 57 per cent of the total catch at Lander (including those returned). Of the 3,996 smallmouth caught 488 or 12.2 per cent were kept during 1956 when the legal minimum length regulation of 10.0 inches was in effect. A sub-sampling of the length frequency distribution of anglers' catches for 527 smallmouth by the creel census taker and cooperating anglers revealed that 65 per cent of the fish were in the 9.0 to 10.0 inch class.

The harvest of smallmouth and associated species in relation to the available population, in terms of weight, is shown in Table 2. Population samples by electrofishing before, during and after the creel census period resulted in an estimated average of 16 pounds per acre for smallmouth 9.0 inches or longer. The harvest of smallmouth calculated from creel census records was 3.2 pounds per acre or about 19 per cent of the weight of the average standing crop. There was no significant change in the pounds per acre, number of smallmouth per

TABLE 2. FISH POPULATION AND HARVEST, LANDER, POTOMAC RIVER, JUNE 1 THROUGH SEPTEMBER 30, 1956

Species	Estimated Population (Pounds Per Acre[1])	Estimated Harvest (Pounds Per Acre)
Bluegill	7	*
Blue Catfish	10	*
Brown Bullhead	2	*
Carp	12	*
Channel Catfish	31	11
Crappie[2]	2	*
Eel	7	*
Fallfish	3	*
Hog Sucker	17	0
Largemouth Bass	2	*
Pumpkinseed	1	*
Rock Bass	3	*
Redhorse Sucker	51	1
Smallmouth Bass	16	3
Yellowbelly Sunfish	14	2
Yellow Bullhead	2	*
Creek Chub	1	*
Miscellaneous Species	1	*
Total	182	18

*Less than one pound per acre.
[1]Smallmouth 9.0-inches-plus, all other species 5.0-inches-plus.
[2]*Pomoxis annularis* and *P. nigro maculatus*.

acre or length frequency distribution of the stock after the creel census period which represented over 90 per cent of the year's total fishing effort. Population samples one mile above and one mile below the sample sector revealed no appreciable change in the structure of the smallmouth populations. The growth rate of smallmouth and immigration into the Lander area were responsible for the replacement of those fish creeled during the fishing season.

In June 1957 the minimum legal length for smallmouth was reduced to 9.0 inches. The effect of this changed regulation on the creel of smallmouth is shown in Table 3. In 1956 the average number of smallmouth creeled per hour was 0.06, in 1957 0.13 or more than twice as many. The number of pounds of smallmouth harvested in 1957 was 5.1

TABLE 3. SMALLMOUTH BLACK BASS CREEL CENSUS ANALYSIS FOR THE YEARS 1956 AND 1957, LANDER, POTOMAC RIVER, FREDERICK COUNTY, MARYLAND

	June		July		August		September		Totals		Average Per Acre	
	56	57	56	57	56	57	56	57	56	57	56	57
Fish Caught Per Man Hour	.43	.29	.39	.36	.64	.56	.59	.27	.51	.37		
Fish Kept Per Man Hour	.06	.11	.05	.13	.05	.18	.07	.12	.06	.13		
Weight of Average Fish Kept in Ounces	13.3	10.2	11.3	16.7	9.7	13.8	10.0	10.5	11.1	12.8		
Harvest in Pounds	195.3	337.8	91.8	204.7	106.7	167.9	241.3	206.7	635.1	1017.1	3.2	5.1

per acre compared to 3.2 per acre for 1956. The increased harvest of 1.9 pounds per acre is associated with the decrease in the minimum legal size to 9.0 inches. However, it should be pointed out that the total fishing pressure in 1957 was 5,966 hours compared to 7,944 hours in 1956, or 75 per cent of the 1956 effort. Had the fishing pressure of 1957 equalled that of 1956 the catch might have been 6.8 pounds per acre or more than double that of the previous year. The decrease in total hours fished in 1957 was caused in large part by an exceptionally hot summer accompanied by drought conditions. Population estimates for smallmouth and associated species were substantially those of 1956 shown in Table 2. There was no evidence of a decline in the abundance of 9.0-inch-plus smallmouth available to anglers at the end of the 1957 creel census period.

MORTALITY

The mortality rate for the smallmouth population was estimated after the completion of analysis of age frequencies from 691 fish collected by electrofishing in Frederick County in 1955. Fish in Age-Groups II through VII were included in the analysis. The method of computing the mortality rate was that described by Rounsefell and Everhart (1953). The annual mortality rate for the 9.0 inch-plus population was calculated as 566 fish per thousand or 57 per cent; the annual survival rate as 434 fish per thousand or 43 per cent. Instantaneous mortality was calculated at 0.923. Examination of fish in Age-Group VI and VII revealed generally poorer condition factors than those computed for younger fish even though there was an abundance of food organisms present. Some of the Age-Group VI and VII fish were blind in one or both eyes.

Monel metal ring jaw tags stamped with serial numbers and inscribed "Return to Md. Warden" were placed around the mandible of smallmouth in 1955 to estimate mortalities caused by fishermen and to study migration from the point of tagging. Of the 330 smallmouth over 10.0 inches tagged 39 or 12 per cent were reported recovered by anglers in the years 1955 and 1956. Tagging of largemouth bass by the same method as that for the smallmouth has resulted in a much higher return for heavily fished Maryland impoundments, averaging 62 per cent for stocked legal-size fish throughout the state. Returns from native largemouth tagged in Montgomery County near Great Falls of the Potomac were 7 per cent. Returns from the river basin for tagged rock bass were 4 per cent and for channel catfish 2 per cent. The return of 12 per cent for tagged smallmouth was twice that for all other species combined which was 6 per cent.

The total annual mortality rate (natural mortality plus fishing mortality) of 57 per cent calculated for 1955 did not result in a decrease in abundance of smallmouth. Electrofishing, haul seining and spawning studies reveal abundant stocks of young-of-the-year, yearling and older age-groups with the 57 per cent annual mortality rate. There appeared to be a large segment of harvestable size bass between 9.0 inches and 10.0 inches which were disappearing through natural mortalities and which the anglers might creel with a reduced size limit together with an extended season.

MANAGEMENT

As a result of analyses of the population, spawning potential, determination of growth rates, creel census and estimate of mortality, the minimum length for smallmouth has been reduced from 10 to 9 inches. Furthermore, recommendation has been made to eliminate the closed season for smallmouth in the Potomac River.

Population studies combined with creel census reveal a large standing crop and a low harvest of fish species associated with smallmouth in the river basin. To encourage the harvest of rough fish and maintain a favorable balance with more desirable species the use of dipnets with no creel limit for carp, eel, hogsucker, redhorse sucker and white sucker is now permitted in Allegany, Washington and Frederick counties from November 1 to May 10. The use of the long bow is permitted for the taking of carp throughout the year in the river. Gigging of rough fish species is now permitted in Washington and Frederick counties under supervision of Commission personnel. Minimum sizes and creel limits for all panfish species have been removed with a year-long fishing season in all counties in the river basin. Signs informing anglers of the abundance of certain panfish or roughfish species at particular landings point out the desirability of harvesting these lightly exploited fishes for the betterment of all fishing.

SUMMARY

Studies by electrofishing throughout the river basin in 1955 revealed that smallmouth formed approximately 8.2 per cent of the population by weight. Desirable species formed 39.9 per cent, rough fish or less desirable species, 60.1 per cent by weight. Spawning of smallmouth was determined to be successful in tributaries and the river with the spawning period during May in 1955 and 1957 and during May and early June in 1956. Growth rate and condition factor of tributary smallmouth is inferior to that of river fish. The harvest of smallmouth from a 200-acre test area supporting a standing crop of about 16

pounds per acre of 9.0-inch-plus bass was 3.2 pounds per acre in 1956 with a minimum size of 10.0 inches. In 1957 with a minimum size of 9.0 inches the harvest increased to 5.1 pounds per acre. Calculation of total mortality rate and fishing mortality for smallmouth revealed a high natural mortality of fish over nine inches which could be made available to the sportfishery with a reduced size limit and extended season.

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DISCUSSION

DISCUSSION LEADER TACK: It seems to be that this is another in a series of papers indicating that restrictions can be removed without any great danger.

CHAIRMAN SHIELDS: Mr. Barry, could you tell me what you believe is the optimum per cent harvest by weight? You gave figures, I believe, the first year was 19 per cent. But what would be the optimum year of harvest of smallmouth by weight, and what would be the optimum per cent?

MR. BARRY: From our records for the whole length of the river, we believe it would probably be close to twenty or twenty-two pounds, or at least about 46 per cent.

MR. JOHN FUNK [Missouri Conservation Commission, Columbia, Missouri]: I wondered why you retained a length limit of nine inches. Why retain the nine inches? It would seem that you are practically removing it altogether. Why don't you go the whole way?

MR. BARRY: Well, education is education and I think we are going through a period where the old-time fisherman is still interested in catching big bass. In fact, we have had considerable discussion with fishery authorities who are familiar with this river and they feel that increasing the lower group may increase the older age groups. But that, in our opinion, is rather fallacious, because we are going to have more and more fishermen and therefore, we are still going to decrease the larger fish.

So I think that eventually we will probably eliminate the size limit. I might add that there is no serious effect on the fishery that most fishermen would be concerned about. We think the rough fish are the greatest decimating factor, counting pollution and all other factors in this particular area.

CHAIRMAN SHIELDS: You recorded one season in which the water warmed up much later in the year than in the other two seasons. Do you have any data on the age rate of growth and total growth in those two years? Was there a definite decrease in the total growth attained by the fish during the cold-water year as compared with the warm water years?

MR. BARRY: Mr. Sanderson, I am sure, feels the fishery is in excellent condition and regardless of the period, they will pick up rapidly when growth conditions in the river are good.

AN ECONOMIC EVALUATION OF THE SPORT FISHERY IN MINNESOTA

ZANE SCHEFTEL

Department of Conservation, St. Paul, Minnesota

Since the end of the Second World War, America has seen a great increase in the popularity of sport fishing. In 1956 Minnesota sold over 900,000 fishing licenses, which is an increase of eight per cent since 1946. The revenue from the sale of fishing equipment, boats and motors, has increased many fold and the sport fishery has become one of Minnesota's more valuable resources. In an effort to evaluate this resource reliably, the Department of Conservation conducted an intensive investigation of expenditures made for fishing in Minnesota. This study was in two parts; part one being an investigation of the expenditures of non-resident anglers while they were in Minnesota on a fishing trip, and part two being a determination of all expenditures for fishing made by Minnesota residents in Minnesota. Part one of this investigation was accomplished during the winter of 1956-57 by means of a mail survey, of a representative sample of non-resident anglers. Part two was conducted during the fall of 1957 with a representative sample of resident anglers contacted by personal interview.

The major objective of this study was to arrive at a reliable estimate of the total revenue accruing to various persons and organizations engaged in servicing the sport fisherman in Minnesota. Information of this kind cannot be obtained directly from the sales records of the businesses involved since in most cases those engaged in servicing fishermen also are engaged in other pursuits so that their sales records contain information unrelated to revenue properly charged to the sport fishery. An indirect approach was therefore necessary and it seemed that the most logical approach was to investigate the other side of the ledger and obtain information relating to expenditures for fishing made by the individual fisherman. This approach assumes of course that the fisherman can recall with reasonable amount of accuracy what he has spent for fishing during the period under investigation. It is recognized that in the individual case errors of recall can and do occur, but an examination of the data lead one to believe that these errors are in most cases errors of omission and, therefore, the various estimates of expenditures tend to be an understatement of the case rather than an exaggeration. To fulfill certain supplementary objectives a good deal of information was collected on the habits and preferences of those fishermen included in the study.

METHODS

In general the methods used in this study are those in common practice among sociological research agencies. For part one, the study of non-resident anglers, the sample is considered to be a stratified random sample drawn as outlined below.

At the outset it was realized that it would be impossible to draw a true random sample with the resources available since no listing of non-resident anglers exists. Fortunately a carbon copy of the fishing license is made at the time of sale and this copy was obtainable from many license agents, and upon request a supply of these carbon copies was obtained from 65 of Minnesota's 87 counties.

For the purpose of drawing a representative sample the State was divided into nine areas on the basis of the types of fishing each area afforded. A quota was assigned each area on the basis of the number of licenses sold in the area in 1955 and a random sample of proper size was drawn from the license duplicates which were available from that area. This method assured that each major area would be represented in proportion to the number of fishermen who used the area.

On November 13, 1956, a questionnaire (Fig. 1), letter of explanation, and stamped self-addressed envelope were sent to the 1522 persons drawn in the sample. Of this number 83 were immediately returned for want of proper address. An investigation of these returns

YOUR FISHING TRIP IN MINNESOTA IN 1956

Please fill out the following questionnaire and return it in the enclosed stamped, self-addressed envelope. No postage is necessary.

1. Did you do any fishing in Minnesota this past summer? Yes ________ No ________
2. How many trips did you make to Minnesota this past summer on which you fished? ________________________
3. How many days did you fish in Minnesota last summer? ________________________________
4. How much did you spend for fishing in Minnesota last year?

If these expenditures include persons other than yourself, how many persons are included? ________________________

Food & Refreshments	________	Fishing Equipment and Supplies	________
Lodging	________	Special Clothing used for Fishing	________
Transportation	________	Camping Equipment Used Primarily for Fishing	________
Boat & Motor Rental	________	Other Miscellaneous Expenses Not Included in Above	________
Bait	________		
Guide Service	________		
Packing and Shipping of Fish	________		

Total Cost of Fishing in Minnesota ____________________

PLEASE INCLUDE ONLY SPENDING DONE IN MINNESOTA.

5. What kind of fish made up most of your catch? ________________________________
6. What kind of fish would you prefer to catch? ________________________________
7. Did you fish for stream trout? Yes ________ No ________
8. Near what town did you do most of your fishing? ________________________________
9. Did you do any winter fishing in Minnesota in 1956? Yes ________ No ________
10. During the time that you spent fishing in Minnesota did you stay at a Resort? ________, Hotel or Motel? ________, With friends or relatives? ________, Camp out? ________, or other? ________, (explain) ________________________

THANK YOU VERY MUCH FOR YOUR COOPERATION

Figure 1. Questionnaire mailed to non-resident anglers.

disclosed that in most cases the cause of mis-address was that either the fisherman had given a common name for his place of residence which was at variance with the official post office designation or there was no street address given for a place large enough to require one. Returns from the first mailing began to arrive within three days and continued at a rate of about fifty per day for ten days, when the rate of return dropped sharply. Ten days after the first mailing there were 570 returns in all. A second mailing elicited 498 more returns by the 26th of December, which was considered the cutoff date. There was then a 75 per cent return from both mailings. In connection with part two of the study the Department contracted with a private research firm to carry out personal interviews of resident anglers. The sampling design was similar to that outlined by Cochran (1953) as a stratified two-stage sample with the primary sampling units chosen with probability proportional to size. The primary sampling units were places (villages, towns, townships) named in the 1950 "Population Census Report" of the U. S. Bureau of Census. Sampling places were chosen with probability proportional to their population as censused in 1950. Implicit in such an approach is of course the assumption that the distribution of anglers within strata is very similar to the distribution of population. There were over two thousand interviews conducted at 80 different sampling places throughout the state. Space does not permit reproduction of the questionnaire used for residents; however, it was essentialy similar to that used in the mail survey. (See Fig. 1.)

DISTRIBUTION OF EXPENDITURES

The expenditures of Minnesota's fishermen are itemized in Table 1. These figures represent the total expenditures of both resident and non-resident fishermen. The amounts shown for transportation represent only out of pocket expense for non-residents but the estimated total operating expense of auto transportation including depreciation was included for residents. This total operating cost was assessed at a rate of ten cents per mile. Also, an additional expenditure, depreciation of boats, motors and trailers, was included in the resident column. This amount represents depreciation at a rate of ten per cent on the estimated total capital investment in these items. It should be noted that over three-fourths of the total expenditure was for food, lodging, and transportation.

The average total expenditure among the non-residents amounted to $96.86. This is close to the amount spent annually by fishermen over the nation as revealed by the U. S. Fish and Wildlife Service survey of 1955 (U. S. Fish and Wildlife Circular 44). The average expenditure of individual resident fishermen is harder to assess since these fishermen are licensed under both individual and combination licenses, with the combination licenes including both husband and wife. The average total expenditure by individual license holder was $83.93 and

TABLE 1. ESTIMATED ANNUAL EXPENDITURE FOR SPORT FISHING IN MINNESOTA

	Non-Resident	Resident	Total	Per Cent
Food	$10,050,000	$13,570,000	$23,620,000	23.8
Lodging	9,710,000	6,300,000	16,010,000	16.1
Transportation	4,510,000	34,260,000	38,770,000	39.0
Fishing Equipment	1,430,000	3,160,000	4,590,000	4.6
Boat Rental	990,000	2,530,000	3,520,000	3.5
Bait	930,000	3,140,000	4,070,000	4.1
Guide Service	370,000	170,000	540,000	.6
Clothing	310,000	780,000	1,090,000	1.1
Packing of Fish	170,000	220,000	390,000	.4
Camping Equipment	110,000	590,000	700,000	.7
Other	480,000	2,280,000	2,760,000	2.8
Depreciation of Boat, Motor and Trailer	....	3,290,000	3,290,000	3.3
Total	$29,060,000	$70,290,000	$99,350,000	100

the expenditure per combination license holder (man and wife) was $134.74. Although it appears that a man and wife can fish at less cost than can two individuals, it should be considered that the women licensed under the combination license do not fish as often as the men.

THE SPORT FISHERY AS A RECREATIONAL RESOURCE

Although the major objective of this study was to estimate the economic value of the sport fishing resource, information was also collected reflecting the recreational value of the resource. Minnesota fishing waters furnish a large amount of good recreational opportunity to both residents of the State and visitors from all over the country. It was found that very few non-residents fished in Minnesota during the winter season, but they enjoyed about 2,850,000 trips during the summer season. The survey showed that Minnesota residents made a total of 9,200,000 trips during the 1956-57 fishing season. About 2,700,000 of these trips were made during the winter fishing season. From another source, the extensive statewide creel census (Moyle and Franklin, 1955), it is estimated that the average length of a fishing trip in Minnesota is two and one-half hours. Roughly speaking, then, Minnesota's 2,000,000 acres of inland fishing water furnish about 30,000,000 man hours of fishing. This is about 15 man hours per acre over the season. This finding is very similar to that reported by Moyle and Franklin (*op. cit.*) in the creel census of a representative sample of Minnesota lakes.

On the basis of 2 million acres of inland fishing water, the expenditure for sport fishing in Minnesota amounts to an average expenditure of about 50 dollars per acre of fishing water. The present best estimate of the annual sport fishing harvest in Minnesota is about 25 million pounds (50 million fish) and on this basis average expenditure for fish taken amounts to four dollars per pound of fish and two dollars per fish.

TABLE 2. SPECIES OF PREFERENCE AND ACTUAL CATCH OF FISHERMEN IN MINNESOTA[1]

Fish	Resident Preference	Resident Catch	Non-Resident Preference	Non-Resident Catch
	Per cent	Per cent	Per cent	Per cent
Walleye	48	18	68	40
Northern	17	15	26	41
Panfish	19	40	16	34
Bass	6	3	23	14
Bullhead	3	8	4	8
Trout	4	2	2	1
Other	5	9	..	..
Not answered	2	6	4	6

[1]These columns do not add to 100 per cent because some persons expressed a preference for more than one species of fish and of course many persons caught more than one species of fish.

Table 2 indicates the relative popularity and rate of catch of the various fish. Although the order in which the various species are preferred and most caught is similar it can be seen that, although the walleyed pike is by far the fish of preference (among residents and non-residents alike), it was the more easily caught panfish that made up most of the residents' catch.

CONCLUSION

The survey shows that during the 1956-57 fishing season that there was nearly $100,000,000 spent for fishing in Minnesota waters. Moreover, this resource furnished nearly 30,000,000 man hours of angling. It may be fairly said then that the Minnesota sport fishery is one of Minnesota's important resources.

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DISCUSSION

DR. GEORGE W. BENNETT [Illinois Natural History Survey, Urbana, Illinois]: Does your figure on the expenditures of non-resident anglers include amortized cost of equipment or just what they spend within the state?

MR. SCHEFTEL: As far as the non-resident angler is concerned, it does not include depreciation on equipment. However, as far as the resident fisherman is concerned, it does. And on one major piece of equipment, that is boats, motors and trailers, my estimate is that the replacement cost on boats, motors and trailers, now in use in Minnesota, is about three million dollars.

DR. BENNETT: I think that amortization figure should be in there. In other words, you figure what equipment an individual has and amortize the items on the basis of the average length of time they last. I think that the annual cost figure for that equipment is a valid figure to include in a study of this kind.

MR. SCHEFTEL: Yes, I agree with you that it is. However, it is very good in theory but in practice you run into difficulty in deciding how to depreciate a sinker, for instance, over a period of time. The practical problems are too great.

DR. BENNETT: A sinker, yes, but not a fly rod, an outboard motor, or a motor boat or other larger items.

MR. SCHEFTEL: Perhaps I didn't make it clear. We did include outboard motors, boats and boat trailers as a depreciable expense. We find that the total capitalization of these items is around 32 million dollars and we depreciate these at a rate of 10 per cent per year so the replacement cost we figure to be around three million dollars.

DR. KARL G. JOHANBOEKE [U. S. Army Engineers, St. Louis, Missouri]: You mentioned a 50 per cent return and then later got a 25 per cent return by going after the non-resident licensees again. Was there any difference in the results of these two, or was this analyzed, Mr. Scheftel?

MR. SCHEFTEL: Yes, we found no significant difference in the fishermen's expenditures for the various items between the first wave of returns and the second.

MR. KENNETH CARLANDER [Iowa State College, Ames, Iowa]: Does ten dollars a fishing trip by a non-resident licensee sound right?

MR. SCHEFTEL: No, sir.

DISCUSSION LEADER TACK: I might comment on that, I think the speaker used trips in two ways. On a vacation trip which comprised almost ten days the non-resident apparently fished about ten times during that particular period but it would be called one fishing trip.

MR. SCHEFTEL: Yes, that was the case.

MR. CARLANDER: Will you give the figures again on cost per fishing day for the non-resident?

DISCUSSION LEADER TACK: I would like to give you this piece of information from this paper. Ninety-six dollars eighty-six cents is the cost of a vacation trip which comprised on the average about 9.6 days.

MR. BLAIR JOSELYN [Southern Illinois University, Carbondale, Illinois]: Did you say how much of the 70 million dollars spent by residents went for transportation?

MR. SCHEFTEL: No, I didn't, and I am again sorry I don't have the figure.

MR. JOSELYN: How much would you say? Would you say about 90 per cent, 80 per cent, 75 per cent?

MR. SCHEFTEL: I have it broken down this way. I say over 75 per cent was spent for food, lodging and transportation.

MR. DAVID T. HOOPS [Iowa State College, Ames, Iowa]: In your evaluation of fisheries from a monetary standpoint, have you ever thought of assessing a minimum value to the man hours based on some minimum hourly wage to get an estimate of the value of fishing or hunting based on the time spent in terms of dollars and cents? It seems to me this may prove another way of evaluating the fishery which might open some eyes and expend the entire evaluation to a rather considerable degree.

MR. SCHEFTEL: That is, perhaps, a good idea. The purpose of this paper, however, was to try to show the value of our fishing waters as a resource, not in its value to an individual, but its value to the state.

MR. E. KLIESS BROWN [Idaho Fish and Game Department, Boise, Idaho]: I would like to know what it cost to make the survey and what funds you used? Was it D. J.?

MR. SCHEFTEL: Yes and no. The mail survey of non-residents was paid for out of Fishery General Funds, which are funds provided by the taxpayers in the State of Minnesota. The interviewing of the resident fishermen was financed from the Dingell-Johnson Funds, and it cost us about $250 in out-of-pocket cash to carry on the mail survey and about $4,500 to carry on the survey of resident anglers. This is in addition to a good deal of office time expended.

MR. EMILE BARRY [Maryland Game and Inland Fish Commission, Hagerstown, Maryland]: I might comment on that last question. In Maryland, we carried out a closely controlled survey, and it cost the Federal Government about five thousand dollars to get about the same survey for game and fish.

DISCUSSION LEADER TACK: It seems to me this is extremely important information, which several other states are trying to get at this time. But so little attention has been given to the desires and capabilities of the people, that it seems to me this is an excellent approach.

TECHNICAL SESSIONS

Tuesday Morning—March 4

Chairman: ALLAN W. STOKES
Assistant Professor, Utah State University, Logan, Utah

Discussion Leader: FREDERIC H. WAGNER
Wildlife Research Biologist, Wisconsin Conservation Department, Madison, Wisconsin

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UPLAND GAME RESOURCES

THE IMPORTANCE OF JUVENILE BREEDING TO THE ANNUAL COTTONTAIL CROP[1]

REXFORD D. LORD, JR.
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This paper presents life tables demonstrating magnitudes of reproduction and mortality of Illinois cottontails and emphasizes the contribution by *juvenile* females to the annual crop.

The epiphyseal cartilage test developed by Thomsen and Mortensen (1946) and refined by Hale (1949) has made it possible to identify young of the year up to January. Sowls (1957) cites articles by authors who reported occasional instances of young cottontails bearing young during the first summer of their lives. These are Ingles (1942), Cooley (1946), and Hendrickson (1947). Ecke (1955) and Bowers (1955) also report juvenile breeding. Sowls (1957) reports 11 of 31 breeding females (*Sylvilagus auduboni arizonae*) as being less than 9 months old. The writer and his predecessor, Lysle Pietsch, have several records of juveniles (*Sylvilagus floridanus mearnsi*) marked in early summer while still quite small, which when later recaptured showed unmistakable signs of having bred during the interim.

[1]A contribution in part from findings of Illinois Federal Aid Project No. 42-R, the Illinois Department of Conservation, the United States Bureau of Sport Fisheries and Wildlife, and the Illinois Natural History Survey, co-operating.

TABLE 1. MONTHLY SAMPLES OF COTTONTAIL RABBITS, CENTRAL AND SOUTHERN ILLINOIS, JANUARY-SEPTEMBER 1957

Month	Number in Sample			Number of Females		Prevalence of Pregnancy	Prevalence of Lactation	Mean Number of Embryos Per Female[1]
	Total	Males	Females	Pregnant	Lactating			
January	16	6	10	0	0	0	0	0
February	25	8	17	3[2]	0	0.18	0	0
March	29	18	11	8	3	0.73	0.27	3.09
	16	12	4	3	4	0.75	1.00	
						0.74 (mean)		
April	25	14	11	4	10	0.36	0.91	1.44
May	23	14	9	7	9	0.78	1.00	6.58
June	12	6	6	5	6	0.83	1.00	5.54
July	0							4.46[3]
August	19	10	9[4]	7	6	0.88	0.75	3.08
	19	7	12	6	11	0.50	0.92	
	25	8	17[5]	3	8	0.33	0.80	
						0.57 (mean)		
September	25	13	12[6]	1	3	0.25	0.75	0.85
	18	5	13[7]	1	6	0.09	0.55	
	10	6	4	0	0			
						0.17 (mean)		

[1]All adults (gravid and nongravid) and gravid juveniles.
[2]Sites of implantation only.
[3]Calculated mean based on June and August means.
[4]One was too young to breed.
[5]Seven were too young to breed.
[6]Eight were too young to breed.
[7]Two were too young to breed.

METHODS

Monthly samples of rabbits were collected from January through September 1957 from several counties in central and southern Illinois. The rabbits were taken at night along country roads with the aid of a spotlight and shotgun. One sample was taken during most months; two samples were taken in March and three each in August and September. Rabbits were brought into the laboratory for examination. The sex, age, weight, and tarsus length were recorded for each animal. Males were checked for the position, weight and volume of the testis and presence or absence of sperm in the head of the epididymis. Females were checked for presence or absence of embryos, placental scars, corpora lutea, and milk in the mammary glands.

OBSERVATIONS

The data upon which these observations are based are presented in Table 1. These data are analyzed for the prevalence of pregnancy, prevalence of lactation and the average number of young per female and include all adult females (barren and non-breeding) and breeding juvenile females. The breeding season lasted for 6 months and 3 weeks in 1957, starting the last week in February and ending the second week in September.

The prevalence of pregnancy rose to a peak in March followed by a dip in April. In May and June the prevalence of pregnancy returned to a second high level, which it probably maintained through July. During July two attempts to find rabbits on the roads at night failed. The three August samples show gradually diminishing reproduction. The second sample was taken from central Illinois, while the first and last samples were taken from southern Illinois. They indicate that there is probably little if any difference between the breeding season in the southern and central part of the state. September showed a continuation of the regression of the breeding to zero by the last week of that month.

The mean number of embryos in 48 pregnant females was 5.52 ± 3.11. In August, 55 per cent of the breeding females (including parous juveniles) were juveniles. In September this figure rose to 76 per cent. The mean prevalence of pregnancy for the 7 months of the breeding season was 0.59 per month. The mean litter size times the mean prevalence of pregnancy times the number of months of the breeding season (6.75) equals the mean number of young per female for the entire breeding season (the gestation of cottontails is 30 days and copulation can take place almost immediately following parturition). If the samples taken during this study are truly representative of the

TABLE 2. MODIFIED LIFE TABLE FOR ILLINOIS COTTONTAIL RABBITS—1957

Month	Adults (Start of Month)	Juveniles (Start of Month)	Births (End of Month)	Adult Deaths (End of Month)	Juvenile Deaths (End of Month)	Rabbits (End of Month)
January	233	2626	0	76	853	1930
February	157	1773	0	77	853	1000
March	1000	0	1486	76	853	1557
April	924	633	638	77	852	1266
May	847	419	2665	77	853	3001
June	770	2231	2028	77	853	4099
July	693	3406	1463	76	853	4633
August	617	4016[1]	1984	77	852	5688
September	540	5148[2]	889	77	853	5647
October	463	5184	0	77	853	4717
November	386	4331	0	76	853	3788
December	310	3478	0	77	852	2859

[1]Since 55 per cent of breeding females in August were juveniles, then 354 of these were breeding juveniles.

[2]Since 76 per cent of breeding females in September were juveniles, then 795 of these were breeding juveniles.

average reproductive condition of female cottontails in Illinois, then the average female cottontail that survived the entire breeding season produced 21.98 young. This figure includes all possible breeding females, barren adults as well as breeding juveniles.

Assuming a stationary population (*i.e.* one in which the number of births and deaths are equal for the year), and a 50-50 sex ratio the annual probability of dying is equal to all deaths $\div$ total population and, in this case, can be calculated by $21.98 \div 23.98$ (young plus original pair of adults) $= 0.92$.

Table 2 is a modified theoretical life table for 1 year for cottontail rabbits in Illinois. It begins with a theoretical 1000 adults in March. The annual probability of dying is applied to this population and spread evenly over the 12 months of the year as shown in the column headed adult deaths. When the average number of deaths per month is some fraction of a whole animal, the fraction is saved and expressed in terms of a whole animal some later month. The data from Table 1 concerning the number of young per female per month were applied to the mean number of adult females (one-half of adults minus one-half of adult female deaths) each month of the breeding season to determine the number of births for each month. In the cases of August and September where juvenile breeding must be considered, the number of possible breeding juveniles was calculated from the 55 per cent in August and 76 per cent in September of breeding females that were juveniles in the samples for these 2 months. The average number of young per female for these 2 months was used to calculate the number of births contributed by breeding juvenile females. The annual probability of dying previously calculated was applied to this juvenile population and evenly distributed over the 12 months of the year. Finally, the number of rabbits present by the end of the month was determined from the number of rabbits present at the start of the month plus the number of births minus the number of deaths.

By applying the probability of dying for 2 months to the individuals born in August, it is possible to determine how many of those surviving to October 1 (termination of breeding) were contributed by juvenile breeding. In the same manner, the number of September-born individuals surviving to October 1 that were contributed by juvenile breeding can also be calculated. The total of these two groups (1383) is 26.7 per cent of the juveniles (5184) surviving to October 1. Thus, juvenile breeding accounted for 26.7 per cent of the annual cottontail crop.

It may be argued that such a theoretical life table is unrealistic because of its equal spread of deaths over the 12 months of the year. On the intensively studied 90-acre research area in central Illinois, the rabbits were censused twice a year, in early October and early February (Table 3).

The census data plus the reproductive data for the state have been applied to another modified life table (Table 3). The principal difference between the two tables is the calculation of both a winter and a summer probability of dying for the juvenile rabbits. It is still necessary to apply the 0.92 annual probability of dying for the adults equally over the 12 months in order to begin this table in February. The number of births for each month of the breeding season is calculated as previously. The probability of dying for juveniles for the summer months was calculated by determining the number of juveniles

TABLE 3. MODIFIED LIFE TABLE FOR ALLERTON AREA I COTTONTAIL RABBITS—1957

Month	Number at Beginning of Month		Births	Number at End of Month		
	Adults	Juveniles		Adult Deaths	Juvenile Deaths	Rabbits
January	7	94	0	4	50	47
February	47[1]		0	4		43
March	43		65	3	32	73
April	40	33	27	4	32	64
May	36	28	112	4	32	140
June	32	108	83	3	31	189
July	29	160	62	4	32	215
August	25	190[2]	83	4	32	262
September	21	241[3]	32	3	31	260[1]
October	18	242	0	4	49	207
November	14	193	0	4	50	153
December	10	143	0	3	49	101

[1]Number based on censuses.
[2]Since 55 per cent of the observed breeding females in August were juveniles, 15 are calculated to have been breeding juveniles.
[3]Since 76 per cent of the observed breeding females in September were juveniles, 29 are calculated to have been breeding juveniles.

alive (242) in October from the census figure (260) minus the calculated number of adults (18) (Column 1, Table 3). Then the number of juvenile deaths (222) is determined from the total number of births (464) minus the surviving juveniles. The number of juvenile deaths during the summer divided by the total number of births equals a 0.478 probability of dying: or 31.7 per breeding month. The number of juvenile deaths for the winter is calculated by assuming a stationary population and from the difference between the number of juveniles present in October and the number expected to be present in February, in this case a little more than 49 for each of the winter months. The total probability of dying for juveniles for the winter months is 0.82.

It is possible to calculate the proportion of the young present in October that were contributed by juvenile breeding in the same manner that it was calculated for the theoretical population above. In this population, 65 August-born individuals and 28 September-born individuals survived to October 1. Of these, 57 were contributed by juvenile breeding. Then, 23.6 per cent ($57 \div 242 \times 100$) of the annual crop of juveniles on this area was provided by juvenile breeding.

SUMMARY

Monthly samples of rabbits taken from various southern and central Illinois counties have furnished many data concerning the reproductive dynamics of cottontails in Illinois.

The beginning and termination of the breeding season have been determined. In 1957, the beginning of the season was indicated with 18 per cent of the sample taken the last week in February showing sites of implantation of the zygote on the uterine mucosa. The last pregnant females were taken the second week in September when 9 per cent wer pregnant. The last week in September no pregnant females were found.

Monthly trends in the prevalence of pregnancy and lactation and the average litter size were determined. The establishment of the mean litter size of 5.52 ± 3.11 and the average prevalence of pregnancy of 0.59 for each month of the season gave a calculation of an average of 21.98 young rabbits produced per female in 1957. The above data also made it possible to calculate an annual probability of dying of 0.92 (assuming a stationary population).

In August, 55 per cent of the breeding females were juveniles. In September this figure rose to 76 per cent. Calculations indicate that juvenile breeding accounts for 24 to 27 per cent of the annual cottontail crop available to the hunters in November. It is suggested that this

portion of the annual crop could make the difference between normally productive years and years of extra productivity. This factor introduces the possibility of predicting the relative size of the annual crop. The proportion of the annual crop produced by juveniles is dependent on three principal factors: (1) the size of the adult carry over from the previous winter, (2) the success of the adult breeding early in the season, and (3) the success of the juvenile breeding. The last factor probably could not be determined in time to be used, but the first two factors might be utilized in setting bag limits each year to take advantage of years of extra productivity.

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DISCUSSION

MR. HOWARD WIGHT [Missouri]: I would like to ask Mr. Lord if he has information as to what time period is involved in the production beyond that which could contribute to breeding in the latter part of the season. How late can young be produced and still breed within the same year?

MR. LORD: I do not know because, as yet, I have not been able to age cottontail rabbits accurately. I am working on an aging technique and when that is developed I will be able to determine how late a juvenile can be born and still breed during the same year. I will also be able to construct age mortality rates for the life tables and make them realistic.

I would like to say that if anyone has some known-age animals that they are using for one purpose or another, I would certainly appreciate receiving the eyeballs of these animals in ten per cent formalin.

DR. J. J. HICKEY [Wisconsin]: Do you still retain the X-rays on breeding in the juveniles?

DR. LORD: These were not X-rayed—they were checked by scraping the bone, which is quite good up until September. After that point I would agree that we would also want an X-ray.

MR. GLENN BOWERS [Pennsylvania]: We have noted a tendency for the young to breed more females during the latter part of the season.

In connection with the earliest that these young would bear, I had a juvenile cottontail pregnant on the 2nd of July and had I had a chance to complete the survey, I am sure that I would have found considerable numbers pregnant during that month.

DR. LORD: That is one reason why I consider my 23 to 27 per cent a conservative figure. Undoubtedly some juveniles must have given birth to the young in July, but I was just not able to obtain a sample for that month.

DR. J. J. HICKEY [Wisconsin]: Dr. Lord, in your last slide, the population started with around 40 animals in January and there were over a hundred in December. This is a population of real magnitude. Do you have any idea what a stable population would be like in connection with juvenile females breeding?

DR. LORD: Of course, I would agree that this was quite a population. However, I found just that mortaliy rate in this population in the form of hair mats, bunches of hair actually lying on the ground, which I consider due to the death of a rabbit on that spot. As a matter of fact, I tested it by throwing out some dead rabbits and within one day the crows had reduced each dead rabbit to a mat of hair and bones; then, by the end of the week, other scavengers had removed the bones. I canvassed the whole area and counted the number of hair mats; it came out very close to the mortality that I found in this area.

DR. HICKEY: Do you actually believe that is what happens?

DR. LORD: Yes, I do. However, I certainly agree with you in that this is hypothetical and I cannot wait to take actual samples each month and then determine the age composition from the samples.

DISCUSSION LEADER WAGNER: Of course, using the percentage of the juveniles in the population as equivalent to the mortality rate is permissible, providing the population remains stationary, and gives the mean mortality rate for the entire population. However, it gives no clue to the variations in mortality rate between the different age classes, and it also gives no clue to seasonal variation in the mortality rate. The mortality rate of the adults almost certainly is lower than that of the juveniles in this population we have seen and, therefore, using the mean, in all probability, overestimates the adult mortality rate.

Furthermore, in all probability, in the first few weeks of juvenile life the mortality rate is considerably higher than during the rest of the year. Using the mean through that period, as he has done in this paper, will underestimate the mortality early in the summer and, therefore, overestimate the number of juveniles alive in late summer or fall.

As a result of this, his estimate of about 27 per cent of the juvenile crop is probably an underestimate and shows that this is probably conservative.

DR. CARL MOHR [Illinois Natural History Survey]: I imagine that, if he followed this population through the year, he would find that a very small percentage of the adults carry over beyond one year. This is about the expected percentage, as shown by the table. Obviously the number of adults carrying over beyond one year was small.

UPLAND GAME-BIRD POPULATIONS IN RELATION TO COVER AND AGRICULTURE IN SOUTHEASTERN WASHINGTON[1]

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Investigators recognize that there is a definite relation between game population densities and cover, but few actual cases are available where upland game-bird populations and cover have been measured over an appreciable period of time. The following paper will describe changes in Hungarian partridge (*Perdix perdix*) and ring-necked pheasant (*Phasianus colchicus*) populations and changes in cover on two areas in Whitman County, southeastern Washington, from 1940 to 1954. This study showed that changes in agricultural practices during these 14 years have been so extensive that profound population changes in huns and pheasants have occurred. In few places have agricultural practices changed so much where such differences have been accompanied by studies on game-bird populations. We are confident that the population densities on the study plots are correlated with the cover reductions and changes in farming practices which have taken place.

The specific data showing these correlations are (1) a series of inventories of the game birds on the study plots, and (2) cover type maps of the two study areas referred to as the Colton and Pullman plots. A general discussion of changes in farming practices should serve to clarify some misconceptions concerning farming in the Palouse region of Washington.

From 1940 to 1941 two upland game bird plots were studied in Whitman County. The work on the Colton Plot was reported by Ball, Knott and Lauckhart (1941); the study of the Pullman Plot was described by Yocom (1943). These two intensive studies included inventories of game-bird populations and detailed mapping of the cover types on the areas.

From 1946 to 1954, a part of the senior author's duties included annual inventories of upland game populations in southeastern Washington. The two plots mentioned above were included in a series of 24 plots distributed over five counties. The Colton and Pullman plots

[1]We gratefully acknowledge the assistance of Leonard Wing, Irvin O. Buss, Helmut K. Buechner, and many students from the State College of Washington for the help that they have given us in inventorying the plots and supplying us with other valuable information; and Mrs. Ruth Elliot, Humboldt State College, who helped in preparation of the manuscript.

are the only ones in the group for which we have pre-war population data. Part of the study of these plots included annual mapping of the cover and the notation of changes.

Description of Weather and Area.—The two plots are representative of the less arid eastern one half of Whitman County. At Colfax the average annual precipitation is about twenty inches and at Pullman it is slightly more than that. In brief it is an area of cold wet winters and hot dry summers. The area, its weather, and its plants have been described by Yocom (1943), Ball *et al.* (1941), Daubenmire (1942) and Buss and Swanson (1950).

It is an area of fertile loess soils which have been deposited by prevailing southwesterly winds. The topography in general is of gentle south and west facing slopes with steep slopes on the north and east. Originally this land was covered by bunch grass with the more favorable sites supporting such trees and shrubs as hawthorn, cottonwood, willow, aspen, rose, and snowberry. At the present time, disturbed areas support such weeds as teasel, burdock, bindweed, wild lettuce, wild oats, knotweed, tar weed, etc.

On the lands at lower elevations along the Snake River more xeric type shrubs occur. On the eastern edge of the county limited stands of yellow pine and Douglas fir are present along the Palouse River and other streams (Daubenmire, 1942). The two plots described in this paper are in an area without desert shrubs or conifers. Pheasants and huns originally found their best habitat in this zone in Whitman County, and it is probable that their highest populations were reached here in the late 1920's at the end of the horse era of farming (Lauckhart and McKean, 1956). Whitman County has been divided into three rainfall zones (Horner, Starr, and Patterson, 1957) which are: (1) the dry farm zone (8 to 12 inches annual precipitation); (2) the intermediate zone (12 to 18 inches) and; (3) the annual cropping zone (18 to 25 inches).

Farming Practices.—Numerous authors (Allen, 1956) have indicated the importance of fertile agricultural soils to pheasants. Farming practices also are of great importance in determining the level of abundance of upland game-bird populations. Dustman (1950) has described the effect on pheasants resulting from the practice of cutting alfalfa at night. Leedy (1939) discusses various methods used in harvesting different farm crops in relation to pheasant production.

Because farming practices are important to upland game birds, this paper will briefly describe these methods. The most important crop is wheat, consisting of two types: (1) fall or winter wheat, which is planted in September or October; and (2) spring wheat, which is planted in April or May. Both types are harvested in August and/or

September. Generally winter wheat produces higher yields but is subject to "winter kill" in some years. Also, it is sometimes difficult to perform all the necessary tillage operations in time to plant all winter wheat. Frequently spring wheat is planted on the basis of not having "all eggs in one basket."

The next crop of importance, dry peas, is planted in the spring as soon as the ground is dry enough, and generally is harvested in August. Minor crops include oats, barley, alfalfa, pasture grass, and sweet clover. Of these, sweet clover is the most significant to pheasants. In April sweet clover is seeded into the fields of wheat, and the seeds germinate and produce a small plant by the time the wheat harvest is completed in September. The stubble in these fields is allowed to stand over winter. By the following late May or early June, the clover is three to four feet tall and is plowed in the bloom stage as a cover crop. The land is then cultivated during the rest of the summer. Prevailing practice is to plant sweet clover about every six years. Thus, in this area, about one sixth of the harvested wheat fields are allowed to stand over winter as stubble because they have been planted to sweet clover. If the present trend toward fall tillage continues, this may be the only stubble allowed to stand over winter in future years. In contrast, about thirty years ago nearly all stubble was left standing over winter.

Subsidy payments for fall discing of stubble were initiated as a means of educating the farmer away from the old practice of spring burning of stubble. Little burning of stubble now occurs in the Palouse; but, even so, this area ranks as one of the critical soil erosion regions in the nation. The very richness of the soil is both a blessing and a curse. With fertility restored by a rotation of sweet clover one year in six, the farmer sees little harm in running rivulets of top soil. Even the reddish sub soil on top of knolls can be restored, for a time, to high fertility by producing a few crops of sweet clover.

The pattern of farming in this area followed that developed in other more arid dry-farming areas; it is known as alternate year or summer fallow farming. A two-year cycle included harvesting wheat in August, plowing the stubble the following spring, and allowing the land to lie fallow all summer. Cultivation of the soil through the summer months was necessary to control weeds preparatory to fall planting. This practice was assumed to be a measure to "store up" soil moisture (Allen, 1953); however, it served only as a means of weed control, for later studies (Jacquot, 1953) have shown that one winter's precipitation is sufficient to produce a crop in those areas of Whitman County which have more than 13 inches annual precipitation. This better understanding of soil moisture storage and the development of weedicides has increased the amount of land which is cropped annually. Subsidy payments and increased annual cropping have resulted in more disced and plowed fields in the fall. This stubble loss has reduced game food and cover.

In addition to this direct effect, there is the invisible effect of increased land valuation. Obviously, land which can be cropped every year is more valuable than land which can be cropped only in alternate years. It is axiomatic that land is farmed more intensively as its value increases. This increased intensity of farming effort has resulted in larger farms, consolidation of fields, more machinery, fewer fence rows, less edge effect, subsidized drainage, elimination of brushy draws, and aerial spraying of insects and weeds. In summary, except for the planting of sweet clover, all factors mentioned have had a tendency to decrease the amount of food and cover in this area.

Other Factors.—Throughout the period of study there has been an open season on huns with the exception of the years of 1946, 1947, 1948, and 1951. The bag limit has been five birds with a possession limit of ten; however, the length of season has varied from year to year.

In th 1930's and including 1940, hen pheasants were legal game in the state of Washington—often restricted to one in the bag. In 1941 the "cocks only" law was put into effect, and it has operated continuously since then. The bag limit has been three birds per day except in 1948 when it was two per day. Until 1946 possession limits were used as a means of controlling kill of pheasants by individual hunters. From 1946 on, a punch card was used to limit the season's take to 15 cocks per hunter—except in 1948 when it was ten. No effort has been made to increase the take of cocks, although sex-ratio studies have indicated that an increased harvest was desirable.

DISCUSSION OF PLOTS

Originally the two plots were studied by different people with varying methods of procedure. Variations which were significantly different will be discussed in the specific discussion on each plot. In general, we do not consider that the counts of the fall populations can be closely compared with those of the breeding season populations because of great variations in cover.

A higher percentage of birds is flushed from the minimum cover in March than is flushed from heavy cover in early October. In general, the plots were inventoried for birds in early March, in early October prior to hunting season, and in early December after hunting season. Variations in weather, students' enthusiasm, bird dogs' abilities and other factors caused distorted counts of birds on some occasions.

If the post-hunting season or subsequent March count of birds was higher than the pre-hunting season count, we used this number as representing the birds the area was capable of supporting in the fall. This seems proper because we are concerned with carrying capacity. Table 1 shows the data obtained on the populations of game birds for both plots. These data show that marked changes in game-bird populations have occurred on the study areas.

Colton Plot.—The 2,560-acre Colton Plot is located seven miles south of Pullman and four miles northwest of Colton in an area which ranges from 2,450 to 2,800 feet in elevation.

Originally, intensive studies of pheasants and huns were conducted here. Post-war census work (1946 on) was concentrated on pheasants, using the ''beat-and-drive-the-draws'' technique with a crew of 10 to 20 students. This type of inventory is a good method for counting pheasants, barring the previously mentioned variables; but it results in less accurate counts of huns, because huns move in and out of permanent cover areas with variations in weather.

The map of the Colton Plot, drawn in 1940, has been used as a base map. Reductions in cover which occurred by 1954 have been indicated on this base map by stippling (Figure 1). In this way, the reductions in cover are apparent at a glance. To insure clarity fence lines have been omitted from permanent cover masses.

Table 2 shows the reductions in fence lines, permanent cover, alfalfa, and over-wintering stubble, for the 14-year period. Fence lines show a reduction of about 37 per cent. The reduction in permanent cover

TABLE 1. INVENTORY DATA ON PHEASANTS, HUNS, AND QUAIL ON THE COLTON AND PULLMAN PLOTS, WHITMAN COUNTY, WASHINGTON

	Colton Plot						Pullman Plot					
	Pheasants		Huns		Valley Quail		Pheasants		Huns		Valley Quail	
Year	March	Fall	March	Fall	March	Fall	March	Fall	March	Fall	March	Fall
1940	48	169[1]	88	101	7[2]	43	12	35	100	323	0	0
1941	....	137	....	172	....	27	14	50	110	340	0	0
1942	132	292	78	110	5	49[5]						
1943	181	....	87	....	10	....						
1946	226	....	15	....	9	....						
1947	292	449	33	96	47	66	33	43	14	57	16	32
1948	291	187[3]	68	41	30	21	32	37[3]	16	25	3	20[3]
1949	108	218	28	35[4]	3	81[6]	28	59	20	40	0	0
1950	92	154[4]	35	13[4]	0	0	25	....	22	....	0	....
1951	154	226	13	46	0	13	30	58	14	39[3]	0	0
1952	95	361	28	77	0	31	21	66	8	28[3]	0	12
1953	224	286	70	23	28	72[4]	19	51	4	7	0	4
1954	229	....	22	....	72	....	13	....	4	....	0	....

[1]Includes 50 game farm birds.
[2]Valley quail planted month previously.
[3]Post-hunting inventory higher than pre-hunting inventory.
[4]Subsequent pre-breeding inventory higher than fall inventory.
[5]Includes 16 Bobwhite quail.
[6]Includes 17 Bobwhite quail.

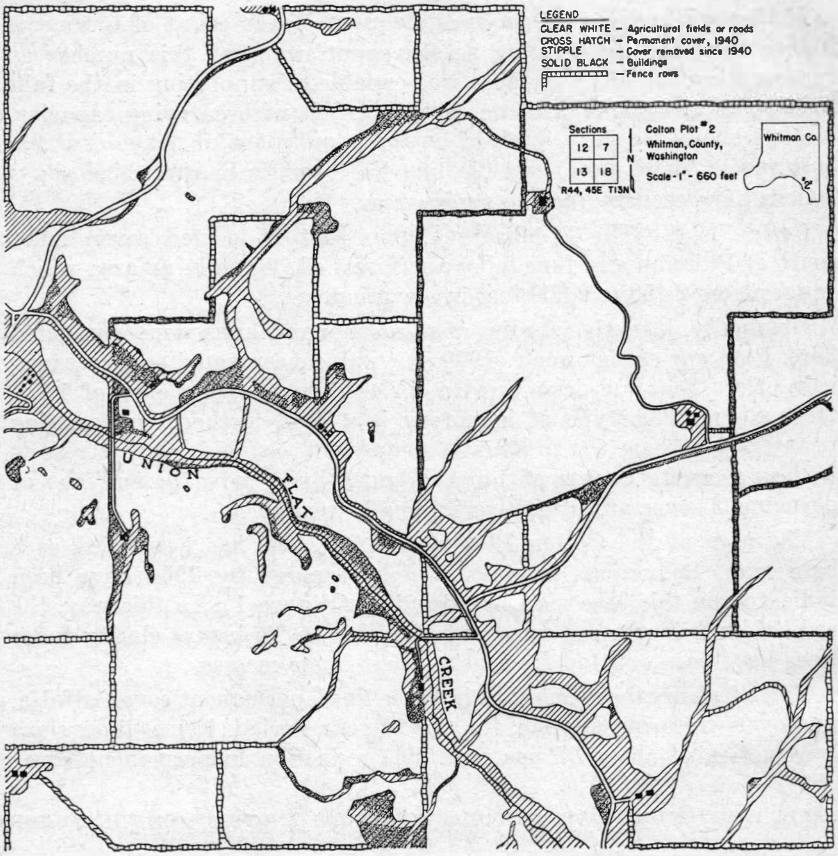

Figure 1. Colton Plot, Whitman County, Washington. Stippled areas show reduction in permanent cover and fence rows since 1940.

was 28 per cent. This reduction is not as crtical as the data implies, for much of it has been in the form of "whittling away" portions of still existing permanent cover areas (Figure 1). When these areas are completely eliminated, further reductions in population will occur. Acreage of alfalfa decreased 76 per cent which is a factor of considerable importance to huns. The amount of stubble left over winter decreased from 535 acres to 329 acres, a reduction of 38 per cent. Such a reduction is of great importance because plowed stubble fields are of little value as food or cover for game birds. Field work has indicated the importance of this factor, since brushy draws bordered by standing stubble are important wintering areas.

Even though the reported reductions in cover and food have occurred, this plot is still considered to be one of the better pheasant areas in the county. A complete check made on the four-section plot in 1947 showed that it furnished 320 man-days of hunting.

While the reductions in cover outlined above were occurring, the populations of upland game birds were varying with amounts of food and cover, and weather conditions. These fluctuations were measured twice each year, in March and in the fall. A trend in game-bird population levels is evident in Figure 4.

Previous to 1941 pheasant hens were legal game. With the closure on hens, breeding populations rose in 1942, 1943 ,and reached peaks in 1947 and in 1948. Unfortunately data are not available for 1944 and 1945 because of World War II. The graph suggests that it took seven years to reach maximum populations of breeding birds. This may have been due to severe winters and/or reproductive failure.

The winters of 1946-1947, 1947-1948 and 1952-1953, 1953-1954 were relatively mild. March inventories in 1947 and 1948 showed pheasant populations at the 300-bird level. In contrast, March populations of pheasants in 1953 and 1954 were at the 225-bird level; this is a reduction of about 25 per cent of breeding pheasants. Because of repeated observations on this area, we feel that this reduction is primarily the result of decreased food and cover.

In contrast to the above, two plots of the 24 studied in the post-war years by the senior author had an increase in cover. Benjamin Gulch Plot 5 from the years 1947 to 1952, had 15 to 50 breeding pheasants. Change of ownership in 1952 resulted in better cover for the winter of 1952-1953. In March 1953 the pheasant population had increased to 103. In March of 1954 cattle use had increased and cover was

TABLE 2. CHANGES IN FENCE LINES, PERMANENT COVER, ALFALFA AND STUBBLE ON THE STUDY PLOTS FROM 1940 TO 1954

Year	Miles Fence Line	Acres Total Permanent Cover	Acres Alfalfa	Acres[1] Stubble Over Winter
COLTON PLOT				
1940	32	324.6	172	535
1954	20	232.6	41	329
Reduction	12	92	131	206
Per Cent Reduction	37	28	76	38
PULLMAN PLOT				
1940	19.5	256.7	127	?
1953	11.5	123.7	7±	0
Reduction	8	133	120	?
Per Cent Reduction	40	52	94	100

[1]In the winter of 1940-1941 much stubble was allowed to remain standing, but we have no record of actual acreage.

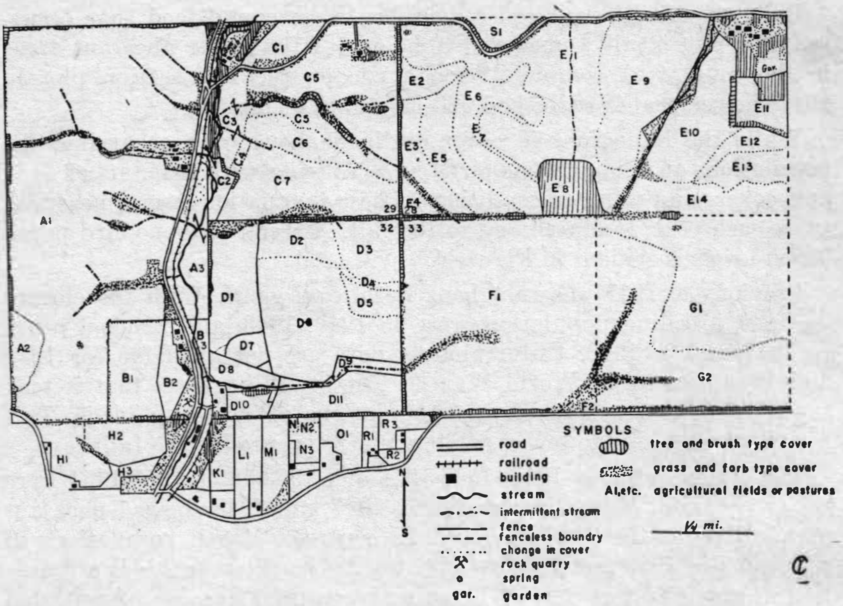

Figure 2. Pullman Plot, Whitman County, Washington. Letters and numbers indicate the fields that were in use in 1940.

judged to be similar to the years 1947-1952. The pheasant population dropped to 40 birds.

The Walla Walla Plot 12 from 1947 through 1950 supported 40 to 60 breeding pheasants. A new owner allowed river-bottom fields of weeds to stand over winter for the four years 1951 to 1954. For these years the population varied between 100 and 140 pheasants.

In addition, the graph (Figure 4) shows the depressant effect of severe winters. After the severe winters of 1948-1949 and 1949-1950, the March populations of pheasants on the Colton Plot were at the 100-bird level. Also the graph indicates that similar breeding populations may produce vastly different fall populations.

The fall population curve for pheasants on the Colton Plot shows peaks for every fifth year—1942, 1947, and 1952. In addition, field men were of the opinion that 1957 was a year of high pheasant populations.

The populations of huns on the Colton Plot followed somewhat the same pattern as that of pheasants, with peaks in fall populations occurring in 1941, 1947, and 1952. The number of breeding huns per year in the early 1940's ranged from 80 to 90 birds. Post-war populations of breeding birds reached peaks in 1948 and 1953 when 60 to 70 huns were counted on the plot. This reduction is similar to the reduction observed in numbers of breeding pheasants.

The population curves of both pheasants and huns indicate that: (1) breeding populations are governed by habitat and (2) fall populations indicate the type of weather during the reproductive season (Buss, Swanson, and Woodside, 1952); however, over a period of years the trend of fall game-bird populations will be depressed by reduction of habitat.

California quail were planted on the Colton Plot in 1940. Since then the number of breeding birds has been related to the severity of the winter. Valley quail were almost eliminated from this plot in the severe winters of 1948-1949 and 1949-1950. Apparently this species is affected by severe winters more than huns or pheasants. Our data suggest that high fall populations are associated with dry summers.

Pullman Plot. — The 1,395-acre Pullman Plot which lies northeast and adjacent to the town of Pullman was established in 1940 for the purpose of studying huns (Yocom, 1943). Post-war inventories on this area started in March 1947. In October 1947, Dr. Leonard Wing conducted two pre-hunt counts. On October 1, a strip count showed 34

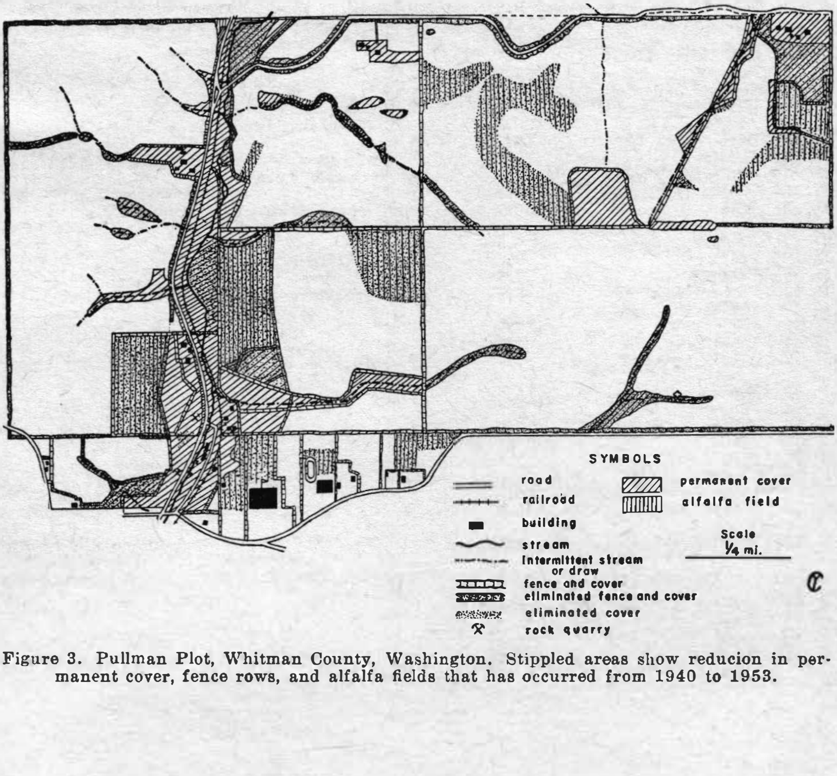

Figure 3. Pullman Plot, Whitman County, Washington. Stippled areas show reducion in permanent cover, fence rows, and alfalfa fields that has occurred from 1940 to 1953.

pheasants and 57 huns. On October 11, a "beat-and-drive-the-draws" method of inventory flushed 43 pheasants and *no huns.* Because the strip count method proved more satisfactory in obtaining data on hun populations, this method was used hereafter throughout the study on this plot.

There are two maps of this area (Figure 2 for 1940 and Figure 3 for 1953). The latter figure shows cover reductions by stippling. On this plot the changes have been so extensive over the 13-year period that we have used two maps and the following tabulation to show these changes:

1940			ACRES IN 1940	CHANGES THROUGH 1953
A	1	Wheat & Peas	230.5	A 1 & 2 and H 1 & 2 one unit (peas)
A	2	Fallow	7.2	
A	3	Grass Pasture	13.4	A 3 (approximately one-half plowed and in alfalfa; one-half in grass type)
B	1	Alfalfa	21.1	Hog ranch established during war
B	2	Pasture	6.6	B 1 & 2 one unit (used as hog pasture)
B	3	Bunch grass	1.9	B 3 bunch grass (same as 1940)
C	1	Peas	8.5	C 1 wheat (field enlarged to include Gun Club; brush removed)
C	2	Pasture	9.3	C 2 fence removed and brush grass type cover remaining only on hillsides; creek straightened and brush bulldozed out. Wheat planted to creek bank.
C	3	Wheat	9.	C 3, 4, 5, 6 & 7 farmed as one unit; brush along draws bulldozed out and grassweed associations reduced
C	4	(Alfalfa in 1941)	1.3	
C	5	Peas	57.5	
C	6	Summer Wheat	10.	
C	7	Wheat	38.8	
D	1	Alfalfa	23.9	(Alfalfa plowed under in 1942)
D	2	Barley	13.6	
D	3	Alfalfa	15.5	(Alfalfa plowed under in 1941)
D	4	Alfalfa & Weeds	2.1	(Plowed under in 1941)
D	5	Barley	6.2	D 1, 2, 3, 4, 5, 6, 7 farmed as one unit—peas
D	6	Wheat	50.5	(all fences between D 1, 2, 6 & 7 eliminated in 1942)
D	7	Pasture	5.5	
D	8	Pasture	8.	D 8 Pasture
D	9	Pasture	7.6	D 9 Pasture
D	10	Pasture & small gardens	3.8	D 10 Pasture (garden eliminated after 1944)
D	11	Wheat	18.5	Peas
E	1	Wheat	63.7	
E	2	Alfalfa	7.5	E 1, 2, 3, 4, 5, 6, 7 & 9 farmed as one unit—wheat
E	3	Peas	15.	
E	4	Fallow	4.7	
E	5	Fallow	20.5	
E	6	Alfalfa	25.8	
E	7	Fallow	5.8	
E	8	Timber culture	13.1	Timber culture conditions similar to 1940
E	9	Peas	50.	
E	10	Wheat	30.5	E 10, 11, 12, 13 & 14 farmed as one unit—wheat
E	11	Alfalfa	8.5	Alfalfa fields were plowed under during war years, and many fences have been eliminated. Orchard, gardens, trees and brush near homestead eliminated.
E	12	Alfalfa	5.9	
E	13	Wheat	10.	
E	14	Peas	21.	
F	1	Peas	152.5	F 1 & 2 and G 1 & 2 farmed as single field—wheat

F	2	Peas	1.0	Fence along road eliminated; no grass or brush cover along road. Timothy grown along swale; mowed for hay.
G	1	Wheat	70.6	
G	2	Fallow	84.	
H	1	Corn	10.	Most of H 1 & 2 now farmed as a unit of A 1 & 2 (see above).
H	2	Wheat	14.4	Fences eliminated in most cases. A small alfalfa field fenced in near house on west side (less than one acre).
H	3	Pasture	3.3	F 1 grown up to grass and brush (not pastured).
J	1	Pasture	1.8	
K	1	Alfalfa	5.5	K 1 in city limits—home built in 1946 on lot
L	1	Alfalfa	7.0	Public school built in 1948
M	1	Fallow	8.3	Part of college horse pasture
N	1	Corn	1.	N 1, 2 & 3 college stables, training track, stand and horse pastures
N	2	Oats	.5	
N	3	Alfalfa	2.5	
O	1	Oats & Barley	8.2	College horse pastures
R	1	Summer Wheat	2.	College horse pastures
R	2	Pasture	2.5	Private lots (homes)
R	3	Alfalfa	4.5	College horse pastures
S	1	Peas	4.5	Peas—The field fence along the road has been removed including shrubs

The detailed changes in the above list are summarized in Table 2 under Pullman Plot. In addition to these reductions, there has been an obvious loss in edge effect, and the city and college have encroached on the area.

The 40 per cent reduction in fence lines is similar to the reduction that occurred on the Colton Plot. The loss of permanent cover for the 13-year period has been about 52 per cent. Reduction of alfalfa has been almost complete—from 127 acres to 7 acres. These changes began during World War II when higher prices were paid for wheat and peas and government acreage restrictions were relaxed. Fences were removed to allow more economical operation on larger fields, permanent cover was removed to increase acreage and to remove pea weevil hibernation areas, and alfalfa was plowed so crops of higher value could be planted. Fall tillage has become so extensive that no stubble is left standing over winter.

It is difficult to point to any single factor as the one causing the reduction in huns on this area. It is probable that some declines occurred during the war as a result of the elimination of alfalfa fields. These declines were accelerated by the elimination of standing stubble. The combination of these factors has affected drastically the populations of huns and has had a less spectacular effect on pheasants.

In examining the range in eastern Washington occupied by huns at the present time, we note that these birds prefer areas where wheat fields join bunch grass and where some brushy draws are available. Thirty or more years ago in the more intensively farmed areas where much stubble remained over winter, huns utilized the stubble in place of bunch grass and high populations were maintained. In the

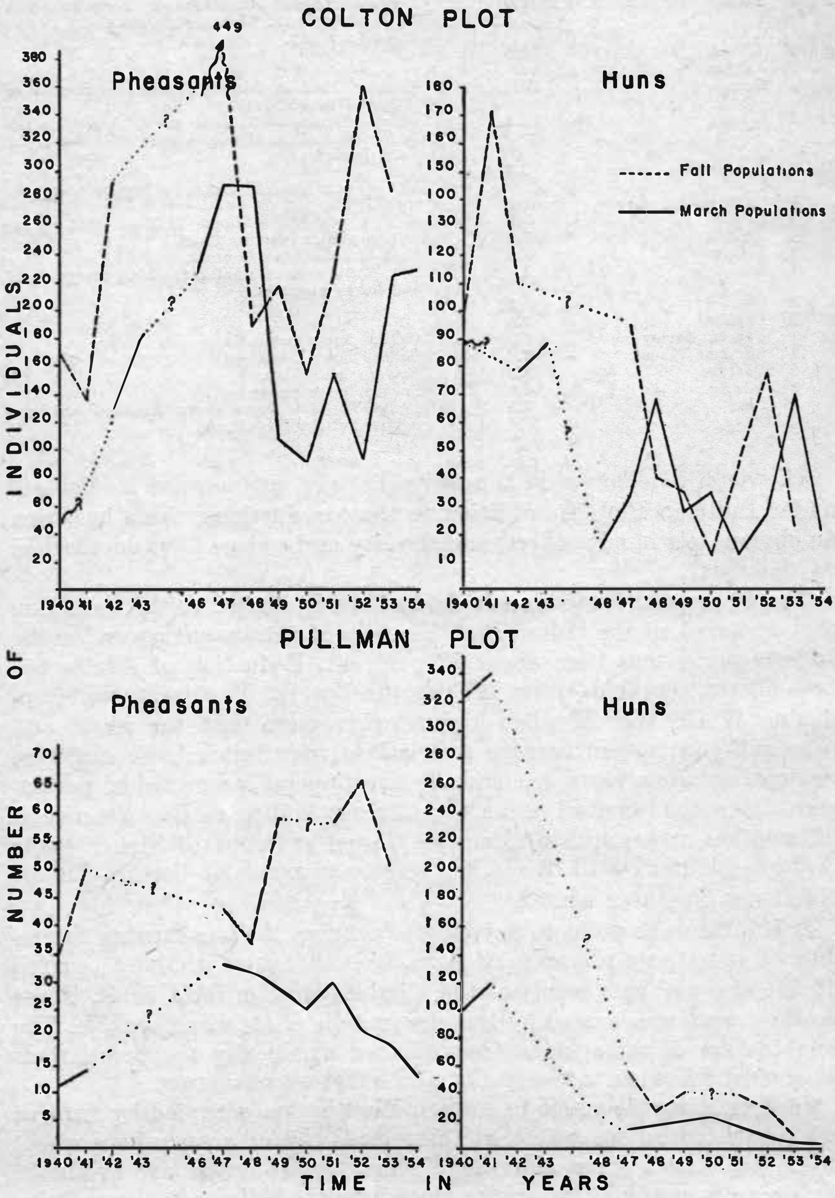

Plate 4. Fall and March populations of pheasants and Hungarian partridges on the Colton and Pullman plots, Whitman Count,y from 1940 to 1954.

spring when the stubble was plowed the birds moved to alfalfa fields which by this time had made some new growth. This suggests that under old methods of farming the hun used the standing stubble as a substitute for grassland.

In much of Whitman County where fall plowing has markedly reduced the acreage of stubble which is allowed to remain standing over winter, huns have declined in numbers. Because standing stubble is effective as a source of food and cover during the critical winter months, we suspect that the reduction in acreage of over-wintering stubble may be one of the most important factors causing the decline of huns in this part of Whitman County. Our observations lead us to believe that huns reduce their vulnerability to decimating factors by using large areas of homogeneous cover. In 1940 and 1941 the Pullman Plot offered large areas of similar cover including standing stubble and alfalfa. During the latter years of our study this plot did not fulfill these requirements which resulted in the reduction of huns using this plot.

Complete elimination of standing stubble, virtual elimination of alfalfa, and loss of permanent cover has resulted in more marked population changes on this area than on the Colton Plot (Table 1). These population level changes are more marked for huns than for pheasants. The breeding populations of huns changed from 100 birds to ten or fewer representing a reduction of more than 90 per cent. From 1947 to 1950 the number of breeding birds varied from 14 to 22. After 1950 further reductions of breeding populations occurred and only four birds were seen in March of 1953 and four birds were seen in March of 1954.

In Asotin County, south of the Snake River, and at similar elevations, the hun populations have varied but no downward trend in breeding populations was noted from 1947 to 1954 by the senior author. There were no significant changes in cover on the plots in Asotin County.

March populations of pheasants on the Pullman Plot shows a downward trend since 1947. The reduction in number of breeding pheasants has been in the magnitude of 60 per cent; however, the number of birds is so few that the percentage is not as important as the consistent downward trend.

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DISCUSSION

MR. JOHN STEEL [Oklahoma]: What is the interval between the peaks and lows on the graph that was shown?

DR. YOCUM: Let's call them fluctuations. However, the peaks appear to occur every five years on pheasants. Generally speaking, there seems to be a fluctuation of roughly five years between. Of course, I am not going to say that I would predict another low or high during the next five years. However, this year was a good pheasant year in that country. However, it is odd that it is working out to the point where we have related fluctuations.

MR. STEEL: Do these populations of pheasants, huns or other birds fluctuate in the same manner and in any phase in the same years. Do they rise and fall in the same years.

DR. YOCOM: The pheasants and huns do. The only thing there is that they fluctuate out of the picture. Of course, they come back, but at a slower rate. Therefore, it has been the policy not to take them off the hunting list. However, when they are scarce people do not hunt them much, and so the situation is self-regulating to a degree.

Of course, I will admit that this is something that may vary by area, for, after all, we do not know too much about migrations as yet, either. Possibly the Sputniks may shed some further light on it. We are just babes in the woods these days. We are facing a new era and I think that we are going to find new techniques and many new things to think about. Obviously, we think of land influence because it is right before us; but think of all the influences on the land from other sources.

MR. FREDERICK: What about the house cat situation on your plots?

DR. YOCOM: I did not want you to bring that up. At one time we had quite a project to exterminate cats. We assumed that every cat was a bird-killer, so we shot all cats that we could get as long as they were outside the farmhouse. However, a complete study of their food revealed that they were not eating an appreciable amount of our game population. As a matter of fact, they were basically eating mice.

MR. FREDERICK: There are thousands of cats in our area. The farmers have moved to town and the cats have just turned wild. These are from abandoned farmhouses out on the prairies.

MR. YOCOM: We found no evidence in our studies to indicate that the house cat was doing our animal population any particular damage.

DR. BUSS [Washington State]: I think it is worth while to point out that the fluctuations you recorded, although not being precise, did agree with the fluctuations that occurred in the southern part of our state. It is also important to point out that these fluctuations have been largely the result of weather conditions during May and June.

CALCIUM, PHOSPHORUS AND PROTEIN LEVELS AS FACTORS IN THE DISTRIBUTION OF THE PHEASANT

FRED H. DALE AND JAMES B. DEWITT

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The primary purpose of gamebird nutrition research conducted at the Patuxent Research Refuge since 1938 has been to shed light on distribution and survival of birds in the field. It was assumed that in order for a species to survive in any area, basic nutritional requirements must be satisfied there. Furthermore, we believed that the availability of certain nutritive factors might vary considerably and that specific deficiencies could be limiting factors in many places.

There are two aspects to this general problem. One involves laboratory study to ascertain basic nutritional requirements. The other is the ecological phase which attempts to interpret these facts in terms of distribution and abundance to the species in the field.

There are certain difficulties in both aspects. The nutrition studies depend on comparisons among various artificial diets devised to test specific factors. Since most of these diets include materials not available in natural food sources, we are seldom sure that requirements for any one factor may not have been modified by some unnatural dietary constituent. To guard against such an event, a wide variety of diets has been compared with substantially equivalent results, so that we are relatively certain that our conclusions are valid within a fairly narrow range of error.

The ecological phase involves greater difficulties, since we cannot subject animals under field conditions to the rigorous control deemed essential in laboratory problems. In the present paper we are reporting the results of laboratory studies in which we have a high degree of confidence. The ecological applications rest on a less firm basis. We hope others will be stimulated to test these applications, since it is by replication of ecological studies that conclusions are validated.

Over the last several years we have conducted research on protein, calcium and phosphorus requirements. These items, especially calcium, have long been considered as basic in the nutrition of the pheasant. Leopold (1931) in attempting to explain the discontinuous distribution of the ringneck over much of its occupied range pointed out that the pheasant succeeds principally in the most recently glaciated areas. He suggested that this distribution might indicate a need for some nutritional factor such as calcium which would be more abundant in these areas. McCann (1939) performed tests with grit in which he demonstrated that glacial gravel was superior to quartz. When pheasants were given quartz grit, intake increased markedly, but the birds exhibited evidence of dietary deficiency. He was able to overcome these symptoms by the addition of calcium carbonate to the diet.

Dale (1954; 1955) reviewed the distribution of the pheasant in relation to availability of calcium in surface soils and demonstrated a high correlation between the abundance of the pheasant and availability of this element. He also tested the effects of limestone provided as grit in connection with an experimental diet and showed that pheasants on a diet considered comparable to that received by the pheasant in the wild reproduced when given limestone grit, but failed on the same diet when supplied with quartz grit. He concluded that pheasants would be unable to survive and reproduce on a diet of corn and small grains without some kind of calcium supplement either in soil or grit. These conclusions were based on an assumed minimum requirement of 0.5 per cent calcium in the diet, or about 250 milligrams a day. It was emphasized that although there is no evidence that the pheasant requires a higher calcium level than other birds, its normal diet is made up of a preponderance of corn and small grains, items which have a low calcium content. This fact was suggested as the possible reason for the failure of the pheasant in much of the corn belt, despite the relative abundance of its favorite food.

Since that time, research at the Patuxent Refuge has attempted to delimit accurately the basic requirements for calcium and phosphorus in relation to the protein level of the diet. DeWitt (in press) has recently reported the results of several years' research on these dietary components. He tested minimum requirements in the growth, maintenance and reproductive diets and demonstrated critical levels below which growth and reproduction are seriously impaired.

Birds reared on growth diets with 15 and 18 per cent protein did not exhibit a normal development pattern. Body weights of these young birds averaged only about half that of those fed the control diet, with 28 per cent protein. Diets with 22 per cent protein permitted growth at a reduced rate, but these chicks were only slightly below the controls at 10 weeks of age. Protein level of the winter maintenance diet seemed to be of little importance in influencing subsequent reproduction. There was some difference in that birds on low protein levels during the winter were lower in reproductive success the following summer, but the results were not statistically significant. It is concluded that pheasants subjected to low protein in the winter diet can nevertheless reproduce successfully the following summer if their reproductive diet is satisfactory.

During the reproductive season there was a clear indication of need for high protein in the diet. Production of eggs and young birds was low for all pheasants on diets containing less than 25 per cent protein. There is one complicating factor here, however, in that the only animal protein in these low protein diets was obtained from dried skim milk. Possibly some other source of animal protein might have been superior and might have enabled the birds to produce more eggs.

The effects of calcium deficiency in the diet were even more striking than deficiency in protein. Birds on winter maintenance diets furnishing 145 milligrams per kilogram per day of calcium and phosphorus had poor success in reproduction, even when the calcium level was increased in the reproduction diet. For the reproduction diet it was necessary to provide about 600 milligrams per kilogram per day of calcium and 385 milligrams per kilogram per day of phosphorus to obtain satisfactory production of eggs and young, and this production was obtained only from birds that had received adequate calcium and phosphorus in the winter.

A further experiment was devised to test the cumulative effect of calcium deficiency. Intermediate levels, 0.5 per cent each of calcium and phosphorus, were used. Reproduction was fairly good for the first year, but mortality of chicks was high during both the growth and winter periods. Of 190 chicks started in the summer of 1954, only 92 were alive at the end of the following winter. Of these survivors, 12 hens on the same diet produced an average of 22 eggs each, but there was an average of only 2.7 chicks per hen alive at the age of 10-weeks. A control group from these birds fed the standard reproduction diet during 1955 produced an average of 12.7 chicks per hen.

DISCUSSION

The growth diet of wild pheasants is largely insectivorous. Consequently it is not likely that it would be deficient in protein. The winter maintenance diet over much of the range is composed of corn, which is low in protein. Nevertheless there is no evidence from our studies to indicate that this deficiency would impair reproduction provided there is a satisfactory protein supplement in the reproduction diet. Ordinarily there is a considerable increase in animal matter at this time, so the pheasant should have little difficulty in obtaining an adequate protein level for reproduction. It may be significant, however, that both alfalfa and soybeans are good sources of protein, and pheasants generally are abundant in soybean- or alfalfa-producing areas.

There is reason to believe that calcium deficiency may be more serious to the pheasant. The dependence of the ringneck on corn over much of its range tends to accentuate any deficiency in calcareous grit, since corn is about the poorest source of calcium available. Alfalfa and soybeans are rich in calcium as well as in protein, and furthermore these crops grow best in calcium-rich areas.

The cumulative effect of calcium deficiency appears to be a logical explanation for what Leopold (1931) called "straggling failure." He pointed out that planted birds may breed, often vigorously the first year, but with rapidly declining vigor until after a few years only straggling non-breeding adults remain, and finally these too disappear.

Calcium deficiency, when the amount available is less than optimum but is adequate to permit moderate reproduction, gives similar results with penned birds. In view of the low calcium availability in areas where straggling failure has been experienced, we are inclined to view this factor as limiting in these situations.

An earlier report (Dale, 1954) was based on an assumed minimum of 0.5 per cent calcium in the diet. DeWitt's results indicate that this level would be inadequate to maintain a vigorous breeding population on a sustained basis.

There still are some unanswered questions as to the management implications of this research. We do not know whether it would be practicable to provide calcareous grit in deficient areas and make some of these unsuitable areas productive for pheasants. We believe, however, that further research on this problem is justified by our work on the basic nutritional requirements of the pheasant for calcium.

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DISCUSSION

MR. JACOBS [Oklahoma]: Would you attempt to apply any of these calcium deficiencies to any other species?

DR. DALE: No, we have not done that. I might say that we did work on the ringneck, which is of somewhat uncertain origin. I don't think that this necessarily is a matter of species requirement. I think that the reason that the pheasant shows up with deficiency of calcium more than any other birds is that the nature of its diet is such to make it susceptible to diet deficiency. Cereals are probably the poorest source of calcium of any food. Quail get by perhaps because they eat more weed seeds.

DR. LEROY KORSCHGEN [Missouri]: I would like to ask Dr. Dale if he had given the pheasants free choice between gravel and limestone?

DR. DALE: No, I did not do that.

DR. KORSCHGEN: I have done a limited amount of pheasant research in Missouri. I have about a hundred samples. Generally speaking pheasants have access to the limestone on the roadways and, of course, there is also some in the field and yet I found that nearly all of the gravel in the gizzard is quartz of some other type and that only about one and a half per cent, approximately reacts as free calcium to an acid test. Therefore, I was wondering whether these birds select quartz over limestone or whether you had done any work on that.

DR. DALE: I don't know how long that material would be expected to stay in the gizzard in the first place. I imagine that it would be dissolved fairly rapidly whereas quartz might stay there for a good many days and so you would expect that, if the amounts of both taken were equal, you would find more quartz than limestone in the gizzard.

DR. IRVIN BUSS [Washington State College]: There are at least a few food-habit studies that show an increase in the utilization of calcium during the breeding season. I think that this in and of itself supports some of the work that you have done, Dr. Dale. I would also think that birds such as the pheasant, which is a persistent renester, has a very high calcium demand because of the large numbers of eggs that it lays. There would be an excellent opportunity for research to determine ovulation incidence frequency and the rates between calcium-fed and calcium-starved lots of birds under experimental conditions. This, coupled with food studies would, it seems to me, give some valuable information.

DR. DALE: There is still a lot of work that needs to be done. We are sorry, frankly, that we are not able to continue, but we feel that we have carried this about as far as we are justified in doing, particularly for an agency that is not primarily concerned with the management of the pheasant. I am sure that you will find a good many different problems closely related to this that can keep you busy for a long time.

DR. KABAT [Wisconsin]: One of the questions that I have is whether, through the large number of brood observations being made in the various states and in the many areas, there has been (or could be) an analysis of detectable differences in brood sizes correlated with the amount of available calcium. My own experience in this regard indicates no detectable differences, at least in Wisconsin. Would you care to comment on that briefly?

DISCUSSION LEADER WAGNER: I would like to just briefly comment on that. In Wisconsin, for the past 11 years, brood sizes in various parts, including some of the most marginal pheasant areas, have been almost identical up to the first 6 weeks of age.

MR. RUMHOLT [Iowa]: Do you think the ordinary application of agricultural limestone as the farmers apply it would meet the limestone requirements of the pheasants?

DR. DALE: Anything that I would say would be an opinion because I have not done any work on it. One of the questions asked us is, how do you account for the fact that road gravel in some areas does not meet any requirement of the pheasant? Well, I don't know. The only thing I know is that in our studies we have found that a deficiency of calcium seems to give the same result that you find in calcium-deficient areas in the wild; I don't know, frankly, whether it is feasible to combat a deficiency of calcium by making limestone available to the pheasants in the wild.

WOODCOCK SINGING GROUNDS AT THE CLOQUET EXPERIMENTAL FOREST, 1947-1956[1]

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This report presents data, gathered over a ten year period, from the Cloquet Experimental Forest in northeastern Minnesota on: (1) spring arrival dates of displaying male woodcock (*Philohela minor*), (2) numbers of occupied singing grounds, (3) the location of these singing grounds in relation to soil types, (4) variations in the years of occupancy of individual grounds during this period in the light of past land use, forest cuttings, and proximity of occupied grounds, and (5) a discussion of these data. It is based on the work of Dangler in 1947 (Dangler and Marshall, 1950) ; on surveys conducted by senior forestry students as a part of their wildlife management work at the Forest each spring since 1947 ; and on intermittent observations by the author.

The Forest lies four miles west of Cloquet in Carleton County, Minnesota. The area covers about 3,300 acres including Sections 29, 30, 31, and 32 of T 49 N-R 17 W and Section 36 of T 49 N-R 18 W. This area, as its name implies, is primarily in forest cover types such as jack pine, conifer-hardwood, aspen, mixed pines, brush, muskeg, red pine, cut-over, tamarack, spruce-tamarack, and aspen-birch. Along with a few open fields, these types are present in a very complex and intermingling pattern (Magnus, 1949). Some of the singing grounds reported on are at the edges of the Forest where abandoned fields and aspen stands make up the bulk of the cover.

The data have been obtained in a similar manner each year since 1947. The forestry students have been given a lecture on the life history and ecology of woodcock and then taken to a singing ground to see an actively singing male during his evening flights and to learn both the peent and flight song sounds. The display usually succeeds in arousing a lively interest. Following this, the individual student has been assigned one of 16 half-mile routes along a road or trail. Later, on a quiet clear evening, he slowly walks up and down this route in the Forest and marks down the location of singing males. This work is carefully timed to include 40-50 minutes following the beginning of peenting activity.

The routes, walked on one or two evenings each year, have been laid out so as to cover thoroughly the portions of the forest known

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to have woodcock singing grounds. However, other parts of the area are sampled by students when the class is larger, and much of the Forest is visited by the author on subsequent evenings to check the students as well as to explore unassigned areas. Singing grounds have been numbered and located on maps so that they may be checked each year. In this way, certainly most, if not all, of the grounds have been discovered. Field notes have been taken on the existing cover at the grounds and these observations have been checked against large-scale aerial photos and the excellent forest type maps of the area.

The work of the students is sincerely appreciated and it is hoped that their interest has been aroused by this experience. Dr. T. Schantz-Hansen and Raymond Jenson of the Experimental Forest staff have been most helpful in supplying maps, data on past history of certain areas, details of the cutting operations and other information. Professors Arthur Schneider, J. H. Allison, and Merle Myer of the School of Forestry have also assisted in many ways while teaching at the Forest. The Soils Department of the University of Minnesota has made available an unpublished soils map of the area.

A description of the singing grounds and the activities of the displaying males is unnecessary here. Dangler's intensive season-long study of 17 grounds demonstrated that the plants occurring in them and the activities of the males using them compare closely with those reported by Mendall and Aldous (1943) for Maine.

ARRIVAL DATES

Information on the earliest reported arrival dates through the years as shown in Table 1 indicates a variation from early April to early May with an average date of April 21. The late dates in 1950 and 1952 were associated with heavy snowfall during March or April of those years.

TABLE 1. ESTIMATES OF OCCUPIED SINGING GROUNDS AT CLOQUET EXPERIMENTAL FOREST, 1947-1956

Year	First Date Seen	Census Date	# Grounds East Forties	# Grounds Other Areas	Total
1947	Apr. 24	All season	10	10	20
1948	?	May 11	15	13	28
1949	Apr. 8	Apr. 26	24	13	37
1950	May 5	May 10	15	6	21
1951	Apr. 16	May 2 & 9	13	4	17
1952	May 1	May 7	12	7	19
1953	Apr. 20	May 4 & 6	10	4	14
1954	Apr. 13	Apr. 29	5	10	15
1955	?	Apr. 27	12	4	16
1956	Apr. 11	May 11 & 12	6	10	16
Average	Apr. 21		12.2	7.1	19.3

NUMBERS OF OCCUPIED SINGING GROUNDS

Table 1 also shows the numbers of singing males reported each year of the study. The data are subdivided into the grounds lying in the eastern half of Sections 29 and 30 and those in the remainder of the Forest. It appears that there has been a gradual reduction in total numbers through the years for the entire forest. However, except for 1949 when there was by far the highest count, and for both 1954 and 1956 which were very low, the numbers have held very well in the eastern areas. In both of the latter two years the number of birds recorded in the remainder of the Forest increased. The reasons for these variations are not known.

It must be stated that the total number of birds this area is capable of supporting is unknown. Certainly there are many apparently suitable spots which have never or seldom been occupied.

RELATION TO SOIL TYPES

During the period 1947 through 1956 singing males have been recorded in sixty-nine different locations. The location of the forty-seven areas known to have been used two or more years is shown in Figure 1. An additional twenty-two locations have been used for one year only. Nearly all of this latter group have been along the northern

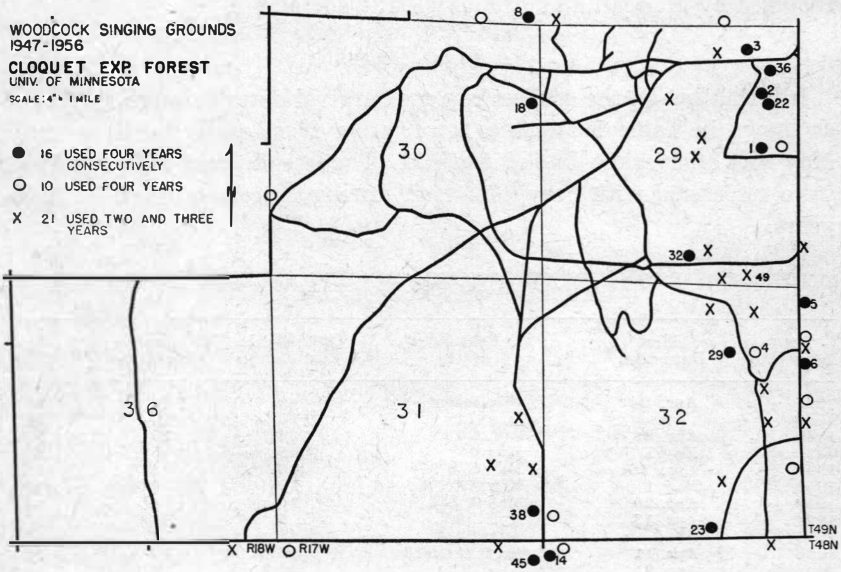

Figure 1. Locations of 47 woodcock singing grounds—1947-1956.

border of section 36 and the north-eastern parts of section 30. These will not be discussed further.

When the distribution of the forty-seven singing grounds, as shown in Figure 1, is compared with the four broad soil groupings (sands, sandy loams, alluvium, and peat) of Figure 2, one reason for the majority of singing grounds lying in the eastern part of the forest seems obvious. Nearly all of the alluvium and loamy soils in the Station are found in this area. The fact that there are some loamy soils just off the Forest at the south corner of sections 31 and 32 emphasizes the importance of these soil types. The large sand and peat areas have almost no singing grounds.

Another point to be considered in the relation of singing grounds to soil types is that, although there have been numerous clear cuts (Figure 3) in the western part of the forest (sections 30, 31 and 36), there has been only one singing ground (#18) used 4 years or more in the cutover areas in these three square miles. The vegetation on these clear-cut areas appears similar to that in the eastern part of the forest. The obvious difference is that there are no loam or alluvial soils in the western area.

From this it appears that proximity to loamy or alluvial soil type is essential to regular use of a singing ground by woodcocks.

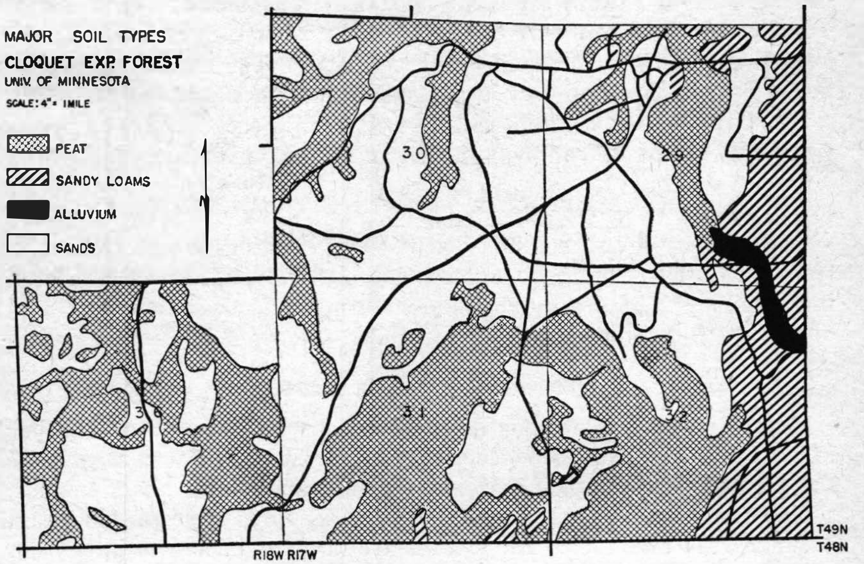

Figure 2. Distribution of major soil types.

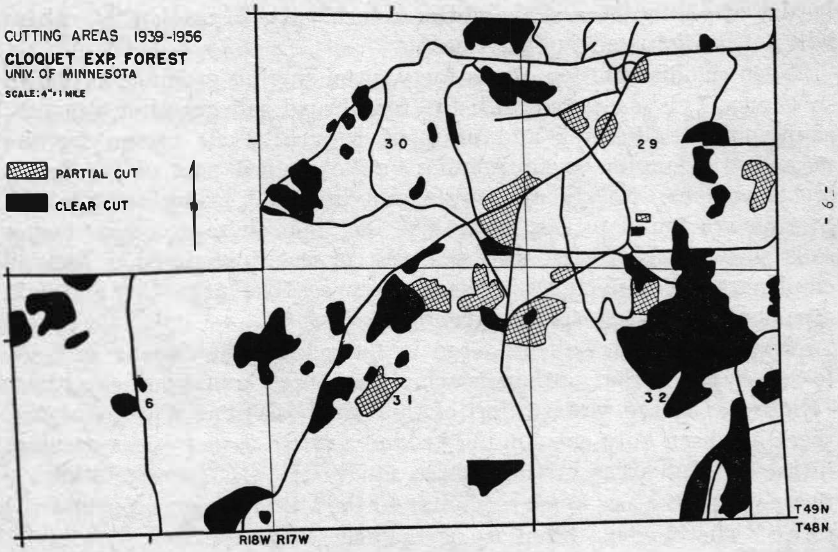

Figure 3. Locations of cutting areas—1939-1956.

The distribution of the major food of the woodcock as reported by Sperry (1940) may well explain this distribution of the singing grounds. Dangler and Marshall (op. cit.) demonstrated that earthworms were found in twenty-six of twenty-seven square foot plots located in alluvium and sandy-loam soil types. The number of worms per sample in these two soils was also highest. In sharp contrast, only seven of twelve peat samples yielded few earthworms and five had none while only one of sixteen plots in the sandy soils yielded an earthworm.

VARIATIONS IN YEARS OF OCCUPANCY

Of the forty-seven grounds discussed in relation to soil types sixteen were used four or more years consecutively. They were located in three classes of areas—abandoned farm land, clear-cut areas, and open swamp-conifer types. These will be discussed in further detail.

ABANDONED FARM LAND

Eight of these 16 grounds lie in areas where farming ceased either in 1935 or 1940. Since woodcock studies were not initiated until 1947 there is no data on their use immediately after land abandonment.

Three of these (#s 1, 5 and 6) were occupied nine of ten years between 1947 and 1956. These three are in areas known to have been grazed very heavily as they were used as milking corrals. Each supported a mixture of about half grassy ground cover and half shrubs twenty odd years after their abandonment in 1935.

The other five grounds show a different sequence of events. Singing ground #2 was occupied in 1947, 1948, 1949, and 1950 by which time jack pine (*Pinus Banksiana*) closed in the area. Ground #22—some 50 yards away but still with brushy growth—has been occupied each year since 1950. In 1948, 49, and 50 when the bird at #2 was disturbed it would light temporarily on #22. This area has had a very heavy growth of bracken fern (*Pteridium aquilinum* L.) which may have retarded volunteer jack pine. Singing grounds #3 and #36 show a somewhat similar sequence of events. The former, at the site of a building torn down in 1935, was occupied in 1947, 1948, 1949, and 1950—at which time a dense invading sprout growth of aspen (*Poplus tremuloides* Michx.) reached eight to ten feet in height. Ground #36 is situated about 100 yards from #3. It was occupied from 1950 through 1953 when the interspersed hazel (*Corylus cornuta* Marsh.) brush and grassy ground cover was plowed for an experimental forest planting.

In some contrast to these two pairs of singing grounds is #38 the only one located on farm lands abandoned in 1940. This ground was occupied in 1949, 1952, 1953, and 1954. It was judged too open and grassy in 1947 and 1948 but did show some invasion by hazel brush at about that time. This indicates a lag in use of old fields. The area was planted in red pine (*Pinus resinosa* Ait.) in 1950 and the planted pines reached 4-5 feet in height in 1954; perhaps the cause of non-use after that year.

From these examples it appears that farm lands in this area might be used by singing woodcock until about fifteen years after abandonment. Probably areas which were "sod bound" due to excessive use by cattle may be useful for at least another five years. There is an indication of a lag in use of open grassy fields which is corrorborated by the fact that there have been such fields along the east boundary of section 29 and the east and south-east boundary of section 32 during this period. These have not been regularly used.

CLEAR-CUT AREAS

Four of the singing grounds used for four or more consecutive years were in clear-cut upland areas. Grounds #4 and #29 lie in an area from which jack and red pines were clear-cut in 1944-1945. Number 4 was occupied in 1947, 1948, 1949, and 1951, at which time very heavy growths of hazel closed up the area. Singing ground #29 is about seventy-five yards from #4 and has been occupied in 1950 and each year from 1952 through 1956. The area it lies in has been scarified repeatedly by plows so as to hold back the growth of shrubs. Several conifer plantings failed here but jack pines established in 1951 or 1952 have now reached five and six feet in height.

Singing ground #18 was in the center of an eight-acre jack pine stand that was clear-cut in 1941-1942. This ground was occupied from 1947 through 1951—at which time volunteer jack pine and planted red pine had grown to a height of six and seven feet. Similarly, singing ground #32 was occupied in 1949 through 1952. The aspen stand here had been clear-cut in 1942-1943 and was first quite bare of woody vegetation but quickly grew up to aspen sprouts that had become dense and 6-8 feet high in 1953.

It would appear from these cases that a clear-cut area in the Forest might be useful to singing woodcock until about ten years after cutting. There may be a two year lapse immediately after cutting when the areas are not used because they are too open. Ground #49 (not one of the four discussed above) which was clear-cut in the winter of 1953-1954 was used in 1955 and 1956 but not in the spring of 1954.

Although as shown in Fig. 3 there were considerable acreages *partially cut* prior to and during the present study, no examples of woodcock using such areas for singing grounds are known.

SWAMP CONIFERS

Four of the grounds used more than four consecutive years are in the swamp conifer type which has not been cleared by logging or farming.

One such ground, #8, has been used eight of the ten years of study. This lies along the creek bottom in an alluvial soil area and was heavily grazed until about 1940. The area presents a similar "sod bound" appearance to that of the three grounds used for nine years each on the abandoned upland farm areas.

Two others, lying on either side of the highway at the south boundary (corner of sections 31 and 32) represent again a pair that are about fifty yards apart. Ground #14 was used from 1947 through 1950 and in 1951 and 1954 while #45 was occupied in 1949 and 1953 through 1956. In 1949 and 1953 the same bird used both grounds on the same night. These grounds are on the shoulder of the highway where maintenance operations kept the brush down.

Singing ground #23 also lies in swamp conifers but in an open brushy glade at the edge of the upland. This area was used from 1949 through 1952 only and there are no data showing a history of past cutting or grazing.

PROXIMITY OF SINGING GROUNDS

The reader will recall that pairs of singing grounds each occupied during different years have been discussed. Thus ground #2 was occupied in 1947, 1948, 1949 and 1950, while nearby ground #22 has been occupied each year since then. Also grounds #3 and #36, which were 100 yards apart, have had different years of occupancy. Grounds #4 and #29 as well as #14 and #45 show similar patterns. These birds have, of course, not been trapped and marked so there is no knowledge of longevity or homing involved here. This pattern of use is thought to be a result of territorialism since it appeared that the grounds used later were suitable all through the period insofar as cover is concerned, and on several occasions fighting on the singing flight was observed.

DISCUSSION

A review of the histories of individual singing grounds indicates that:

(1) They are distributed with relation to alluvial and loam soil types.

(2) Abandoned farm lands may be used for as much as twenty years depending on the rate of invasion of woody plants and/or planting of forest trees. There appears to be a lag in use of abandoned fields until shrubby growth develops in them.

(3) Clear-cut forest areas may be used for up to 10 years—again depending on plant succession or tree planting programs. There may be a lag of one or two years following cutting.

(4) Open swamp-conifer types may be regularly used by singing woodcock. Here a history of past disturbance by grazing or road maintenance was associated with the area used.

(5) Territorialism apparently prevented use of adjacent sites thought to be suitable for singing grounds.

Sheldon (1953) refers to changes in vegetation causing the site to "go by"—evidently a New England colloquialism for closing in of a singing ground by woody vegetation. Since these studies did not include trapping and marking birds the data point to this phenomenon rather than population changes.

There is one broad implication to be derived from the data. This is that, as land abandonment continues in northeastern Minnesota, potential areas for singing grounds will continue to develop. However, if this process goes on irreversibly, these sites used for long periods of time will be eliminated. There are clear indications that this will happen. A further development of clear cutting on short rotations for pulpwood should compensate at least partially for this trend. But such sites are relatively short lived.

SUMMARY

Ten years of observations on occurrence of singing male woodcock at the Cloquet Experimental Forest in northeastern Minnesota are reported. During this time sixty-nine different locations of singing males have been recorded. Forty-seven of these have been used two or more years and appear to be located with reference to loam and alluvial soils.

Sixteen of these have been used four or more years consecutively. Eight abandoned farm land areas—especially those formerly heavily grazed—received use each year for considerable periods of time. Four singing grounds in clear cut upland areas were used for four or more consecutive years. No partially cut areas were used. The swamp conifer type, which had been grazed in the past, was the site of four other grounds receiving use of this order.

The woodcock use or non-use of these areas depended on their supporting partially open brushy cover. Invasion by shrubs or trees to give a solid woody cover brought about non-use. This occurred in 15 to 20 years for abandoned farm lands and by 10 years for clear cut areas. There was a lag of two to four years after abandonment or clear cutting when no use was recorded. Certain pairs of singing grounds located close together showed use of only one area until vegetation closed in. This was thought to be due to territorialism.

Present land-use trends in the region point to many changes in number of potential sites in the future.

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DISCUSSION

DR. WM. SHELDON [Massachusetts]: First of all, did you get much variation in your spring counts, on the same road?

DR. MARSHALL: No, we did not. I realize that it could happen but we made it a point to check and recheck. We are not dealing with marked birds, and so we do not know which individual birds are doing what. It seems to hold fairly steady in the area.

DR. SHELDON: That would be in total numbers. However, did you find that sometimes the birds would be shifting around?

DR. MARSHALL: The ground occupied seemed to be continually occupied, although there is shifting when they are fairly close together.

DR. SHELDON: Further, when you speak of the ground cover being fairly closed in, did you try to measure it specifically?

DR. MARSHALL: On many areas hazelbrush was closing in; on others it was aspen sprouts and on still others it was jack pine. I would be willing to guess that woody vegetation from six to ten feet high covering more than sixty per cent of the immediate area was the point of no return.

MR. KING [New York]: I thought it might be interesting to add some prior history. From 1930 to 1937, I worked this area rather extensively, spending better than half of my time on it and, during that period, there were only three singing grounds.

MR. FRED LANE [Illinois]: It seems to me, from the land management you suggested here, that possibly there are some spots in Illinois that might be favorable to that particular bird. Now, is it possible, on a latitude or geographic basis that they could be introduced in central Illinois?

MR. GREELEY [Illinois]: I have an idea on that. I was interested in the woodcock before I came to Illinois and so I did a little checking up and I am still keeping an eye on it. Near Havana we have one area which, during a spring count, had at least eight birds there, and I have seen at least one brood in Illinois. I don't think that there is any question but what woodcock are breeding in Illinois but there is not much information on their distribution.

MR. BRUCE WRIGHT [New Brunswick]: Did you have beaver in that forest?

DR. MARSHALL: Yes, we did along the creek. However, none of the singing ground reported on here was in beaver flowage.

THE EFFECTS OF HUNTING ON GAMBEL QUAIL POPULATIONS[1]

STEVE GALLIZIOLI AND WENDELL SWANK

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"Of the many species of game found in Arizona the Gambel quail ranks first in importance" (Gorsuch, 1934). With the 15-bird daily limit and 60-day season then in vogue it is little wonder that Gorsuch ranked this bird at the top. It was not many years after the completion of his study, however, that quail hunting in Arizona virtually came to a stop.

Following one of the periodic dips in population characteristic of desert quail, the hunting season was either closed entirely from 1944 to 1951 or limited to short, two- to three-day hunts on restricted areas. Within ten years the status of this game bird changed from that of first to somewhere near last in importance.

It is difficult now to determine with certainty whether the restrictions on quail hunting were due to the belief that hunting had brought

[1]A contribution from Pittman-Robertson Project W-78-R (Arizona).

about the population crash or to concern over the possibility that hunting would aggravate a situation created by other forces. Regardless of the reason, once the practice began of treating this species as though it were on the verge of extinction, there was seemingly some reluctance to again permit a reasonable amount of hunting.

The results of other quail studies, including work on the closely related California valley quail showing that hunting was generally not a factor limiting quail numbers, were evidently not thought to be applicable to conditions in Arizona.

In 1951 a study was instituted with the specific purpose of determining the influence of hunting on desert quail. Was hunting really a limiting factor? And if an affirmative answer was indicated, at what point did it become so? Did quail population density have any bearing on the answer? What percentage of a quail population would hunters take under conditions existing in this state? Would the percentage of take vary, and, if so, how much of the variation was dependent on hunting pressure and quail density? How would a population protected from the gun respond compared to one hunted?

An earlier paper (Swank and Gallizioli, 1954) reported on the first three years of the study. The results of the subsequent four years work corroborate the early findings and shed light on some of the questions posed above.

While most of the work has been confined to the original area near Oracle Junction, a second area was selected for limited study in 1956. Named the Pinnacle Peak area after a prominent landmark, it is located 25 miles north of Phoenix. Like the Oracle Junction area near Tucson, it receives heavier than average hunting pressure due to its proximity to metropolitan Phoenix. It was established largely to provide kill and hunt statistics comparable to those from the Oracle Junction area.

The Pinnacle Peak area lies in a desert shrub type. Dominant plants are sahuaro cactus (*Carnegiea gigantea*) and paloverde (*Cercidium floridum*) with a bursage (*Franseria dumosa*) understory. Shrubby hackberry (*C. pallida*) is abundant. Chollas and prickly-pear are found in varying amounts throughout. Herbaceous cover is scarce with only remnant perennial grasses persisting, mostly tobosa (*Hilaria mutica*). The elevation here is approximately 2,000 feet and annual precipitation at nearby Bartlett Dam averages 12.04 inches.

The original study area at Oracle Junction lies some 20 miles north of Tucson. It is in reality two "areas," one open to quail hunting in season, and an adjacent control area which has been closed to quail hunting since the inception of this study. Elevation is approximately

TABLE 1. SUMMARY OF HUNT STATISTICS FROM ORACLE JUNCTION CHECKING STATION, 1951-1957

	1951[1]	1952[1]	1953		1954		1955		1956		1957	
	All Hunters	All Hunters	Study Area Only	All Hunters	Study Area Only	All Hunters	Study Area Only	All Hunters	Study Area Only	All Hunters	Study Area Only	All Hunters
No. hunters	1594	1099	510	1471	272	1958	225	1275	81	835	61	886
Total No. quail bagged	3234	4304	1012	4807	755	6474	433	3206	25	1388	51	1751
Scaled quail	72	125	82	190	42	184	62	159	2	19	3	16
Average bag	2.03	3.92	2.0	3.27	2.77	3.31	1.93	2.51	0.31	1.66	0.84	1.98
Bag per 100 gun hours	43	99	63	85	84	89	60	63	13	44	32	53
Per cent hunters with limit bags	20	20	6	17	12	17	6	10	0	6	0	9
Per cent juveniles among Gambel quail bagged	44	70	44	43	56	53	30	28	5	20	77	74
Per cent juveniles among scaled quail bagged	56	70	61	63	64	62	45	55	0	35	67	81
No. quail lost per 100 bagged	31	23	29	27	28	29	20	27	28	20	29	26

[1]Study area hunt data were not kept separate in 1951 and 1952.

3,500 feet, and annual rainfall at nearby Oracle averages 18.65 inches. Both hunt and control areas fall in what may be classed a grassland-desert shrub type. Dominant plants consist of a mixture of scattered shrubby mesquites (*Prosopis juliflora*) and hackberry (*Celtis pallida*), several species of cholla (*Opuntia* sp.), soaptree yucca (*Yucca elata*), and barrel cactus (*Ferocactus Wislizeni*) with an understory of burroweed (*Applopappus tenuisectus*), prickly-pear (*Opuntia Engelmannii*) and perennial grasses. Along the washes which intersect the area a more arborescent type of vegetation occurs characterized by larger mesquites, a tree-size hackberry (*Celtis reticulata*), velvet ash (*Fraxinus velutina*), and catclaw (*Acacia Greggii*).

In addition to Gambel quail some scaled quail are found on a portion of this area. Being near the northern boundary of its range in Arizona the scaled quail has never been abundant here. Kill records (Table 1) show it has made up about ten per cent of the total bag. Presumably this is the ratio in which it exists in the total quail population of the area.

PROCEDURE

Early in the study the problem of determining with reasonable accuracy the population densities of the two areas at Oracle Junction became of paramount importance. Foot surveys following compass lines (1951) and over pre-established and marked transects (1952) proved to be subject to great variation when analyzed statistically (Swank and Gallizioli, *op. cit.*).

Since 1953 population density has been calculated by means of the Lincoln Index on the hunt area. Quail were banded during two periods: in September and in November immediately prior to the December hunting season. Trapping in September was confined to a 446-acre segment of the 12-square-mile hunt area. Returns of September-trapped birds permitted a determination of the extent of natural mortality during the September-December period. Checking stations were operated at both study areas thoughout each quail sea-

TABLE 2. HUNT DATA FROM PINNACLE PEAK CHECKING STATION, 1956-1957

	1956	1957
Total hunters	906	1117
Total quail bagged	1485	2059
Man hours hunted	3747	4442
Number birds lost	401	690
Juvenile quail	87	1301
Adult quail	1202	514
Average bag per hunter day	1.63	1.80
Quail bagged per 100 gun hours	40	46
Number quail lost per 100 bagged	27	34
Per cent juveniles in hunters' bags	7	72
Per cent population removed by hunting (bag and cripples)	12	16

TABLE 3. COMPARISON OF FALL POPULATION DENSITY (QUAIL PER 100 ACRES) ON HUNT AND CONTROL AREAS, ORACLE JUNCTION STUDY AREA

Year	Hunt Area	Control Area
1952	67	
1953	71	48[1]
1954	65	63[1]
1955	40	40[1]
1956	9	
1957	13	

[1]Personal communication from Dr. Lyle Sowls dated January 28, 1958.

son to secure an accurate check on banded birds taken and to gather information on quail hunting not only on the study area but in the surrounding territory as well. A summary of hunt data from both checking stations is shown in Tables 1 and 2.

Since the control area at Oracle Junction was closed to hunting it was not possible to determine population density as it was on the hunt area where checking of hunters permitted the use of the Lincoln Index. Other techniques were tried including a formula by Lagler (1950) and a modified Lincoln Index using color-banded birds introduced into the population. Neither proved satisfactory.

From 1951 through 1956 the Wildlife Research Unit at the University of Arizona under Dr. Lyle Sowls conducted intensive quail population studies on several areas near Tucson. One area known as Page Ranch forming part of the control area was studied in 1953, 1954, and 1955. Population density figures for the control area in Table 3 are those obtained by Dr. Sowls for the Page Ranch area.

FINDINGS

Following completion of the seventh year of study several major conclusions can be drawn that are of importance to management.

1. Hunting was not responsible for the population changes on the hunt area.

Density was about the same on the hunted and control areas in 1954 and 1955 (Table 3) but considerably lower on the control area in 1953. When the first significant drop in quail density occurred in 1955 it was equally severe on the control as on the hunted area, amounting to approximately 40 per cent of the 1955 population level. Since the Research Unit's study was terminated in 1955, no objective data for the control area are available for 1956 and 1957 when density on the hunt area reached its lowest level. It is known, however, that numbers were considerably lower than the 1955 level. A drive census by a wildlife class from the University of Arizona in the fall of 1957 flushed but one quail in 80 acres (Sowls, in conversation). From this and limited footwork on our part it seems reasonable to assume that

TABLE 4. GAMBEL QUAIL POPULATION CHANGES ON HUNTED AND UNHUNTED AREAS (MODIFIED FROM WRIGHT AND WEBB, 1957).

Year	Hunted Area		Unhunted Area	
	Population	Per cent change	Population	Per cent change
1953	2060		4193	
1954	2007	− 3	3631	−13
1955	1011	−50	2245	−38
1956	575	−43	1128	−50
Per cent reduction 1953-1956		−72		−73

the control area population dropped to a level probably as low as that of the hunt area.

On an independent study concerned with the value of rainwater catchments in Arizona, Wright and Webb (1957) found a 72 per cent reduction in Gambel quail numbers between 1953 and 1956 on a hunted area and a 73 per cent reduction during the same period on a second study area located on a refuge (Table 4). Obviously the population changes at Oracle Junction were not a local phenomenon since the areas studied by Wright and Webb were more than 100 miles north of Oracle Junction, at lower elevations, and in different vegetative types. Violent fluctuations in southwestern quail have been reported by other workers and are apparently the result of the extremes of wet and dry years. Jackson (1947) and Lehmann (1953) found both bobwhites and scaled quail in Texas subject to extreme changes in population density. In southern Nevada, Gullion (1954) reported equally violent changes in Gambel's quail populations.

2. Under hunting conditions and regulations as they now exist in Arizona, it is unlikely that more than 30 per cent of the prehunt population will be removed by hunters even in the most heavily hunted areas.

During the course of this study the heaviest kill occurred in 1953 when bag and crippling loss combined accounted for 24 per cent of the preseason population. As quail density decreased, so too did the kill until in 1956 and 1957 at Oracle Junction it dropped to an insignificant four to six per cent of the prehunt population (Table 5). The results

TABLE 5. POPULATION DENSITY (QUAIL PER 100 ACRES) AND KILL AT ORACLE JUNCTION STUDY AREA, 1952-1957

Year	Postbreeding (September) Population	Prehunt (December) Population	% Pop. Decrease between Sept. & Dec.	% Prehunt Pop. Removed by hunting	% Post-breeding Pop. removed by hunting
1952	116	67	31	18	
1953	88	71	19	24	19
1954	86	65	25	21	16
1955	53	40	24	17	13
1956		9		4	
1957		13		6	

demonstrate the well-known principle of diminishing returns. As density decreased quail became more difficult to find, and hunters lost interest. The year to year decline in hunting pressure parallels the drop in quail density and hunter success as well as in total kill (Figure 1). The only significant departure from this trend occurred in 1953 when bag per unit effort was substantially lower than 1954 although density was at least as high and perhaps higher in 1953 than in 1954. This discrepancy was probably due to a considerable difference in hunting pressure in the two years: 21 gun hours per 100 acres in 1953 compared to 12 in 1954. The change in hunting pressure in turn was caused by a reduction in size of the adjacent control area in 1954 thereby luring many hunters into this ''virgin'' territory who would normally have hunted on the study area. Most significant is that with roughly comparable quail densities the removal was only three per cent more in 1953 although hunting pressure was almost twice as great as in 1954. This too reflects the operation of the law of diminishing returns. Affected most by the change in hunting

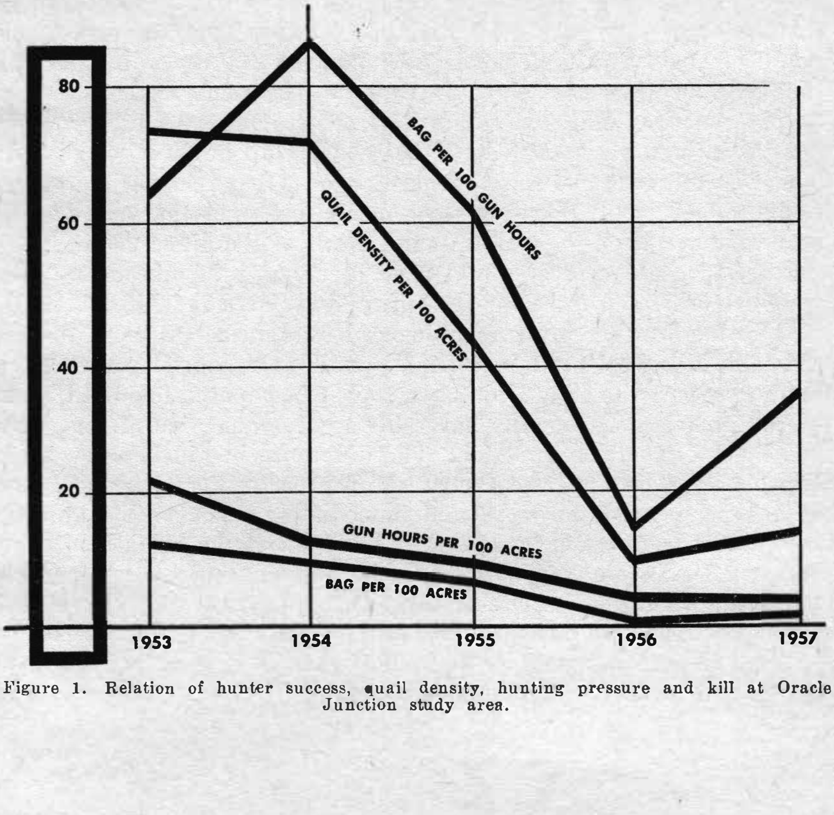

Figure 1. Relation of hunter success, quail density, hunting pressure and kill at Oracle Junction study area.

TABLE 6. COMPARISON OF HUNT AND POPULATION DATA FOR UNITS 1 AND 2 OF THE ORACLE JUNCTION STUDY AREA, 1954-1955

	Unit 1		Unit 2	
	1954	1955	1954	1955
Prehunt density (quail per 100 acres)	97	55	56	39
Hunter success (quail per 100 gun hours)	70	37	88	65
Per cent prehunt population removed by hunting	26	31	20	16
Gun hours per 100 acres	26	31	11	8

pressure was hunter success which went from 63 quail per 100 gun hours in 1953 to 84 in 1954.

A similar relationship is indicated in comparing hunt results of Unit 1 and Unit 2 of the Oracle Junction Study Area (Table 6). A 446-acre section of the hunted area was designated Unit 1 while the balance comprised Unit 2. The division was necessary because only the smaller unit was trapped in September as well as immediately prior to the hunting season to permit a calculation of natural loss during the intervening period.

Removal on the two units was never proportional to hunting pressure (Table 6). In 1954 a removal of 26 per cent on Unit 1 compared to 20 per cent on Unit 2. Hunting pressure that year was more than twice as great on Unit 1 with 26 gun hours per 100 acres compared to 11 on Unit 2. The 31 gun hours per 100 acres in 1955 was roughly four times the eight of Unit 2. The removal, however, of 31 per cent was only twice that of Unit 2. Due to a higher quail density in both years on Unit 1 the relationship is not as clear as it otherwise might be. It was previously shown that removal is proportional to density. It thus seems reasonable to assume that had density been comparable on the two units the effects of the difference in hunting pressure on removal would have been less pronounced—as they were demonstrated to be for the entire study area in 1953 and 1954.

Here too hunting pressure influenced hunter success more than it did total kill. In Unit 1 in 1954, 70 quail were bagged per 100 gun hours, compared to 88 in Unit 2. In 1955, 37 compared to 65 in Unit 2.

At Pinnacle Peak hunters harvested a greater portion of the population than at Oracle Junction. The difference in kill between areas is probably more apparent than real. The per cent removed is based on the per cent of birds banded immediately prior to the hunting season that were taken by hunters. The bulk of the birds banded at Pinnacle Peak were trapped near roads, making them more vulnerable to hunting than those at Oracle Junction where traps were distributed throughout the area and up to one and one-half miles from a road.

While it was not possible to reduce data at Pinnacle Peak to a population density, quail numbers, judging by hunter success, were undoubtedly higher than on the study area at Oracle Junction. A kill per 100 gun hours of 40 and 46 quail was realized at Pinnacle Peak in 1956 and 1957, compared to 13 and 32, respectively, on the study area at Oracle Junction. In accordance with the results over the years at the latter area showing that removal is proportional to density a higher removal would be expected at Pinnacle Peak. This it was, hunters taking 12 per cent of the population in 1956 and 16 in 1957 compared to four and six per cent, respectively, at Oracle Junction.

3. More quail are lost to natural causes in the two month period immediately preceding the December hunting season than are harvested by hunters during 16-day seasons.

During three years it was possible to get reliable estimates of population loss between September and the beginning of hunting in December. The loss has averaged 23 per cent of the September population for the years 1953 to 1955 (Table 5). (The 1952 estimate is probably high.) If the loss sustained from hunting is figured on the same basis, *i.e.,* as a per cent of the September population instead of from the prehunt population, the average removal by hunters amounted to 16 per cent for this three year period—substantially less than the loss to natural factors during the two months preceding the hunt. The significance of this prehunting season loss is discussed in another section.

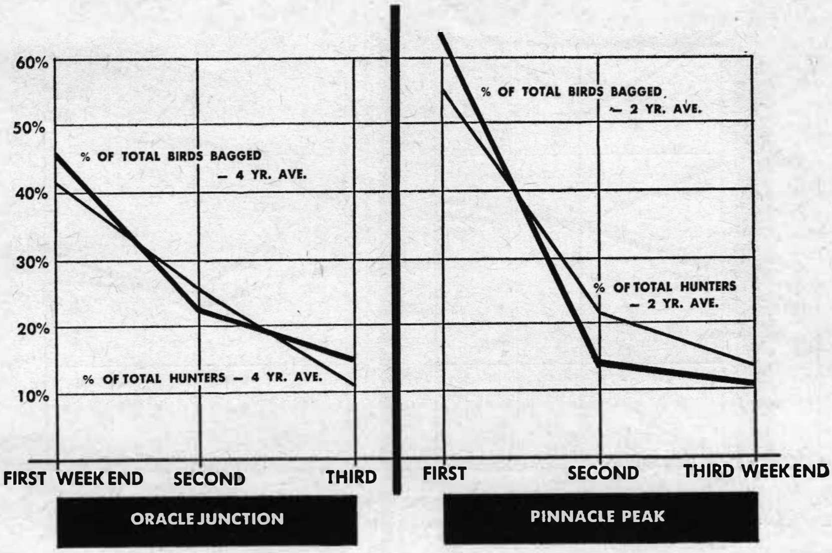

Figure 2. Distribution of hunting pressure and kill through three week-end (16 day) seasons at Oracle Junction and Pinnacle Peak checking stations.

4. Hunting pressure and kill during a hunting season decline as the season progresses regardless of population density or hunter success.

Figure 2 shows graphically the progressive drop in hunting pressure and kill during three week end seasons. At Oracle Junction a four year average shows 43 per cent of total hunters bagging 45 per cent of the quail on the first week end of the season. The last week end accounted for 15 per cent of the quail by 13 per cent of the hunters. At Pinnacle Peak distribution of pressure and kill was even more unbalanced. The two year average showed 53 per cent of the hunters taking 63 per cent of the quail on opening week end, while 13 per cent removed 11 per cent of the quail on the third and final week end.

A decrease in hunting pressure as a hunting season progresses is generally associated with a drop in hunter success. The principle of diminishing returns is generally believed to be at work—as greater effort becomes necessary for each unit of game brought to bag, hunters tend to lose interest. While the operation of this principle was evident in comparing year-to-year data, it fails to account for the decline in hunting pressure as the season progressed. In not one year was there a progressive drop in hunt success from the first to the last week end (Figure 3). In two years at Oracle Junction, 1954 and 1956,

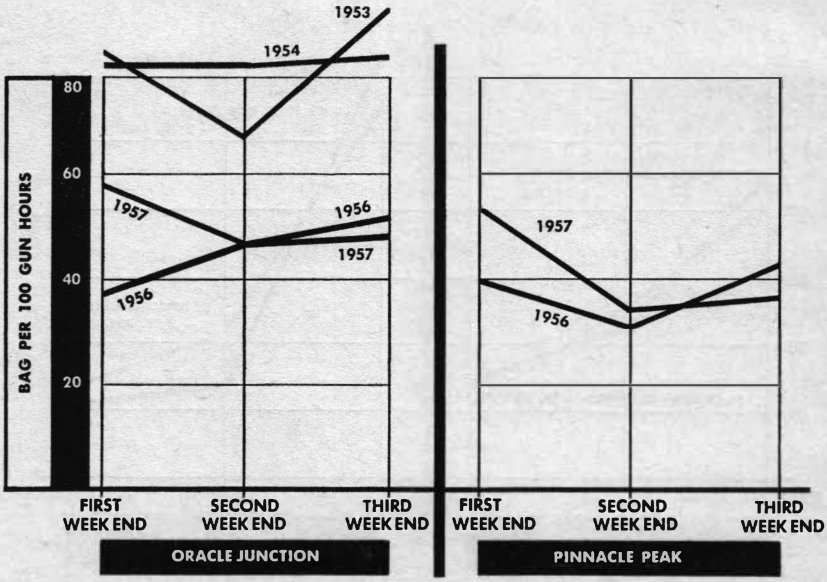

Figure 3. Changes in hunter success (quail bagged per 100 gun hours) through three week-end (16 day) seasons.

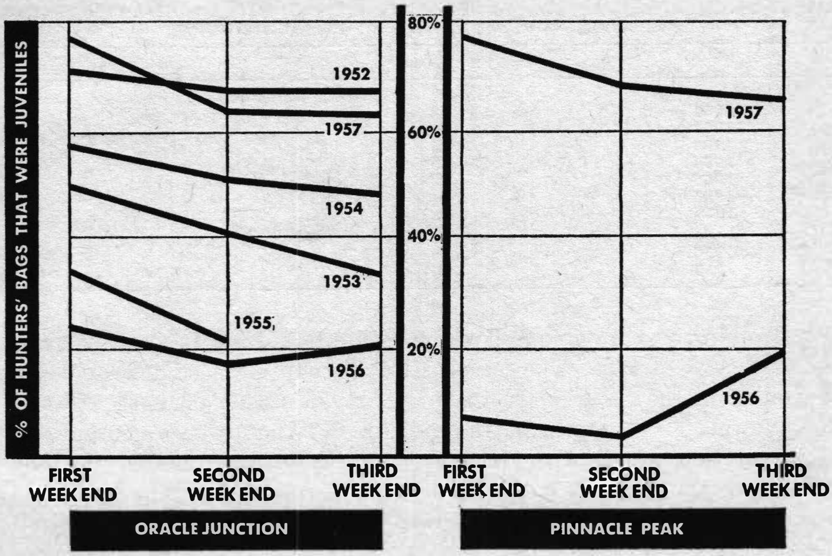

Figure 4. Drop in proportion of juveniles in hunters' bags as season progresses.

success improved steadily from first to third week end; in one, 1953, and one at Pinnacle Peak, 1956, success was higher on the third week end than on the first. Only in 1957 on both areas was third-week end success lower than first, and even here it was somewhat higher on the final week end than on the second. That relative quail density is not a factor here is indicated by the fact that results were the same in years when density was high as when it was low.

5. Hunter success tends to fluctuate with the proportion of young in the population but high density resulting from a good hatch and high survival of young is more of a contributing factor than is the differential vulnerability of young birds.

Gullion (*op. cit.*) concluded that the ratio of young to adult was more important than population density in determining success of Gambels quail hunters in Nevada. While a good relationship between proportion of young in the population and hunter success was found on our study (Table 7) the discrepancies in it raise the question of whether the apparent relationship is not simply due to the population density in most years being largely determined by the proportion of young in the population. That young of the year are more vulnerable to hunting than adults is demonstrated in Figure 4 showing a progres-

TABLE 7. RELATION OF GAMBEL'S QUAIL YOUNG TO ADULT RATIOS AND HUNTER SUCCESS (QUAIL PER 100 GUN HOURS)

Year	Hunter Success	Per Cent Juveniles
	Oracle Junction	
1951	43	44
1952	99	70
1953	85	43
1954	89	53
1955	63	28
1956	44	20
1957	53	74
	Pinnacle Peak	
1956	40	7
1957	46	72

sive drop in the proportion of young in hunters' bags in every year of the study except 1956. The reason for the sharp increase in proportion of young on the third week end of the 1956 season on both areas is not known. There would be little doubt but that of two comparable populations of quail with dissimilar proportions of young, the one with more young birds would produce better hunting. The extent to which a higher proportion of young would offset a lower quail population is a matter of conjecture. However, our data prove conclusively that a high proportion of young does not in itself mean high hunter success. The 74 per cent young found at Oracle Junction in 1957 is the highest for the seven years of the study, yet success is only a trifle higher than that of 1956 when only 20 per cent of the hunted population were juveniles. The 53 quail per 100 gun hours in 1957 when the juveniles made up 74 per cent of the population was considerably lower than the 63 of 1955; the 89 of 1954; or the 85 of 1953 when the proportion of young was only 28, 53 and 43, respectively. Further, success at Pinnacle Peak in 1957, 46 quail per 100 gun hours, was only six per cent more than in 1956, although juveniles made up 72 per cent of the population in 1955 compared to an incredibly low seven per cent in 1956.

DISCUSSION

The fact that hunting has had no influence on Gambel quail populations in Arizona will certainly cause no stir among professional wildlife biologists. Since Errington and Hammerstrom's (1935) early work on bobwhite quail, one small-game study after another has ended on the same note. Most of the investigations along this line have been concerned with bobwhite quail (Baumgartner, 1944; Kozicky and Hendrickson, 1952; Mosby and Overton, 1950; Murray and Frye, 1957; and others). Invariably the conclusion reached has been that a high mortality was characteristic of bobwhite populations regardless of hunting. Pheasants are in a somewhat different class since the practice has been to shoot cocks only. It has been found, however, that cock pheasants are seldom shot down to the level believed desirable or permissible in terms of the number needed for reproduction (Stokes, 1954; Hart, 1954). The list of studies indicating either that hunting was of no significance in maintaining populations and/or an underharvest of small game includes work on virtually all other important species of small game: ruffed grouse (Palmer, 1956), California valley quail (Glading and Saarni, 1944), mourning doves (Newsom, *et al.*, 1957), white-winged doves (Gallizioli, 1955), gray squirrels (Uhlig, 1956), cottontails (Pirnie, 1949 and Atzenhoefer, 1951, and Gambel quail (Gullion, *op. cit.*).

While our findings are thus nothing revolutionary they are but slowly gaining acceptance by a hunting public conditioned by closed or brief hunting seasons to believe that hunting was virtually the only important factor controlling quail populations.

Considering the data on per cent kill, hunter success and amount and distribution of hunting pressure, it appears that under past regulations we have not permanently reduced quail numbers by hunting and that there could well have been considerably more hunting in Arizona without significant effect on quail populations. With the rapid progressive decrease in hunters with three week end seasons it is evident that longer seasons would not contribute significantly more hunting pressure. Further, it is equally apparent from the relation of hunting pressure to total kill that an increase in hunting pressure does not produce a corresponding increase in kill.

The heavy loss to natural factors in the fall months is a well known feature in the ecology of other small game. Knowledge of this factor has prompted game departments to advance their hunting seasons to take advantage of this surplus. An earlier and longer Gambel's quail season in Arizona would be nothing more than sound game management.

SUMMARY

A seven-year study on the effects of hunting on Gambel quail populations revealed that:

1. Quail numbers on an unhunted control area fluctuated about the same as those of a hunted area. When a sharp drop in quail population levels occurred it was equally severe on hunted and unhunted areas.
2. With three week end (16 day) seasons removal by hunting varied from 4 to 24 per cent of the prehunt population (including crippling loss).

3. Removal in any year was directly proportional to quail density; the highest take of 24 per cent occurred in 1953 with quail density at 71 per 100 acres, the low of four per cent came in 1956 when density was but nine per 100 acres.
4. More quail were lost to natural factors between September and the hunting season than were removed by hunting.
5. Hunting pressure and kill decreased rapidly as the season progressed despite the fact that hunter success was generally as high on the last week end as on the first.
6. Although hunter success in any year tends to parallel the ratio of juvenile to adult birds, there is evidence suggesting that quail density is the real determinant of hunter success and that the relation of hunter success to the ratio of young to adult is simply the result of juveniles often being the determining factor in relative quail density.

ACKNOWLEDGMENTS

It would be nearly impossible to list all the people who have helped in one way or another with this study. We are especially grateful to Dr. Lyle Sowls, Leader, Wildlife Research Unit, University of Arizona at Tucson, for critically reading the manuscript and helping in other ways. Ed Webb, Paul Webb, John Stair, Leo Wiltbanks, Norman Woolsey and Gerald Day of the Arizona Game and Fish Department helped with the trapping and banding operations and/or with the hunter checking stations.

Last, but far from least, we gratefully acknowledge the support of former Director John Hall, Game Management Chief Phil Cosper, and the members of the Arizona Game and Fish Commission.

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DISCUSSION

DR. J. J. HICKEY [Wisconsin]: I would like to ask Mr. Gallizioli how he controlled the ingress and egress on the study areas.

MR. GALLIZIOLI: That, of course, is one of the biggest problems. We had no control over that but what we did was to determine the extent of movement of our population in the area by determining how many of the banded birds killed were taken off the area and then reduced our banded population by that amount in calculating our population density.

ECOLOGICAL AND SOCIAL PROBLEMS IN QUAIL MANAGEMENT IN WEST TEXAS

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During the past decade it has become evident that game management consists of more than the solution of ecological problems. Since most of us in this profession are naturalists by inclination that may be somewhat disillusioning. However, we believe it is true that the basic ecological problems of game populations are better understood than the social and economic problems involved in their harvest. Biological research ceases to be effective when application of the knowledge gained is rendered impossible by problems of the latter type. This seems to be a particularly critical phase of game management in Texas where there has developed an increasing unbalance between the hunting population and the opportunity for hunting, despite an abundance of game.

This paper presents an analysis of a regional situation with regard to one species. Its purpose is to illustrate the scope of inquiry that is necessary before effective management can be accomplished.

There are large geographic differences as regards these problems in Texas, as well as important economic differences between game species. In deer populations located near centers of human population a buck has a value ''on-the-hoof'' of $50 to $100, and the market is active at that price. In remote areas adequate numbers of hunters are difficult to obtain, particularly because landowners are unwilling to tolerate them at lower prices. Texas has quail populations—of three species—over nearly all of its area, but quail hunting is limited because it is economically unrewarding to landowners except in a few areas.

MANAGEMENT INVESTIGATIONS

The Area.

The Trans-Pecos Region of Texas, that area west of the Pecos River, comprises roughly 31,500 square miles of land—an area nearly as large as the state of Maine, and almost as large as Vermont, Massachusetts, New Hampshire, and Rhode Island combined. It has a human population of slightly over 250,000, over 80 per cent of which exists in El Paso County, in three per cent of the total area. The Region is largely mountainous and consists almost entirely of private ranches averaging over 25,000 acres in size. Large sections of land are entirely roadless. Except for minor gaps in range, scaled quail are distributed over the entire Region.

Systematic studies of game management problems were begun in 1952 under Federal Aid Project W-57-R. Some of the information presented here comes from Federal Aid Project W-38-R and from studies conducted through the Texas Agricultural Experiment Station. Although the general conclusions apply to several other species, we have chosen to discuss the results of scaled quail investigations.

Ecological Studies.

The initial undertaking was a reconnaissance survey of the general distribution of scaled quail and habitat types. Next, a regional survey of population levels was devised. With all of its shortcomings the roadside cruise technique seemed most efficient for covering such a large area with limited personnel. Nineteen routes totalling 541 miles were finally established. Details of operation of the technique will not be given here, but they can be found in completion reports from the project (Uzzell, Moore, and Wallmo, 1953). Studies by Geis (1952) and by Gallizioli (1957) emphasize the fact that limited statistical reliability can be placed in results obtained by our methods. However, because our data comply with the general conditions found through other work, we find them satisfactory for our purpose, especially in view of considerations pointed out later in this paper.

Two intensive ecological studies of quail were conducted in the Trans-Pecos Region—one in the mesquite sand dunes area of El Paso County (Moore, 1950) and one in the desert grassland—desert shrub transition of Brewster County (Wallmo, 1957).

The most significant information gained from these studies is that scaled quail population levels are controlled principally by climate. While we have no quantitative data from the 1940's, we are aware that it was a favorable period for scaled quail. That decade was characterized by comparatively high precipitation. Severe drought began in 1950 and 1951 over most of the region. By 1953 and 1954 range conditions were desperate. Our observations indicated a population "crash" from 1952 to 1953, probably beginning earlier although we have no measurement of it. There was a slight increase in the average population level indicated by the cruise lines in 1954 even though the drought continued, but this was influenced mainly by a jump in one area where there was a marked increase in winter and spring rain. In 1955 precipitation was generally greater throughout the region and the average population level increased appreciably. The years 1956 and 1957 saw further increases in the population fol-

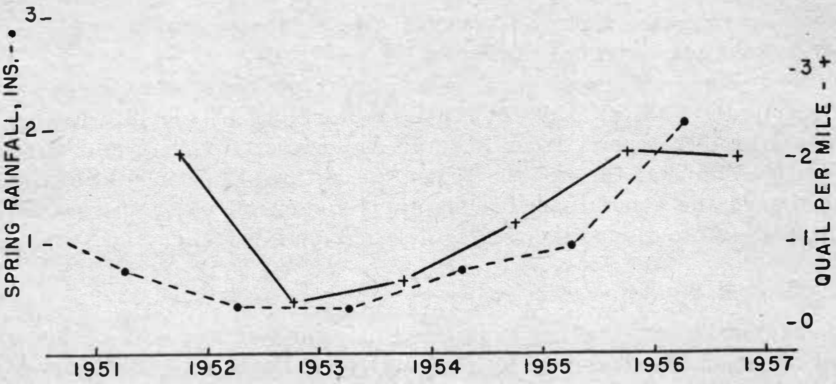

Figure 1. Relationship of fall quail population (in quail per mile of cruise line) and average rainfall for the first three months of the year (from offical stations nearest to the cruise lines).

lowing continued increase in precipitation (Figure 1). Similar responses have been reported for Gambel quail in Arizona (Swank and Gallizioli, 1954).

Intensive ecological studies revealed some explanation of the mechanics of these phenomena. The gross populations of six coveys studied were 152, 134, and 249 birds in the winters of 1952-53, 1953-54, and 1954-55, respectively. The young to adult ratios in those periods were 1.44:1, 0.33:1, and 3.93:1 (Figure 2). There were two obvious differences between the years 1953 and 1954 as far as quail ecology is concerned. First, the amount of precipitation received in the first half of 1954 was twice that received in 1953. Second, the amount of green herbaceous vegetation available prior to and during the early part of the breeding season was 10 to 36 per cent greater in 1954 than in 1953. Food habits studies revealed that there was a significant difference in the amounts of green forage ingested and in the quantities of vitamin A stored in livers preceding and during the breeding seasons of 1953 and 1954. Nutritional studies of quail in other areas lend substance to the conclusions that we have drawn (Lehmann, 1953; Schultz, 1948; Harper, *et al,* 1953).

We now feel that a cause-and-effect relationship can be drawn between precipitation during a critical period of the year and breeding success. While a positive correlation can be found between precipitation and young:adult ratios, it is obvious that gross populations will not correspond as closely. Experience in other areas of Texas indicates that several years of favorable conditions are required for the development of peak quail populations, and high populations may continue well beyond the inception of adverse conditions before a population crash occurs (Jackson, 1957, p. 16).

Analysis of Hunting Pressure.

A survey of hunters and their success was initiated in 1953 to study the December, 1952, hunting season. Postal card inquiries were mailed to all license buyers in the region. A cross check was made by personally interviewing a group randomly selected from the total. This survey was repeated for the 1953 and 1956 hunting seasons. For the 1954, 1955, and 1957 seasons bag checks and interviews were used as a basis for estimating average success. Gross license sales for the region were determined and data from the 1952, 1953, and 1956 polls provided a basis for estimating the approximate percentage of this total that were quail hunters. Total harvest was estimated therefrom.

The history of hunting pressure and hunting success as related to quail population levels is indicated in Figure 3. Perhaps most significant in these data is the fact that there is not a direct correlation between quail population and total harvest or between quail population and hunting pressure.

Our surveys revealed that the number of quail hunters among all license buyers in the Trans-Pecos Region has varied from approximately 1,100 to 1,500 during the past six hunting seasons. In Texas, quail can be hunted within the hunter's county of residence without

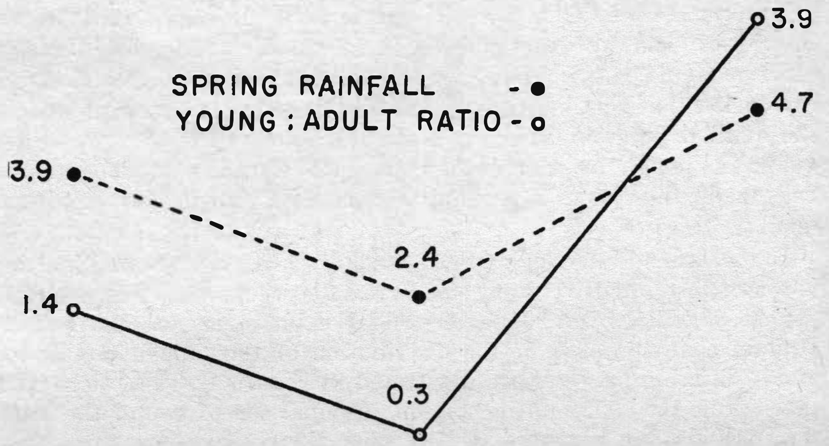

Figure 2. Relationship of reproductive success and spring rainfall, based on history of six coveys on Brewster County study area.

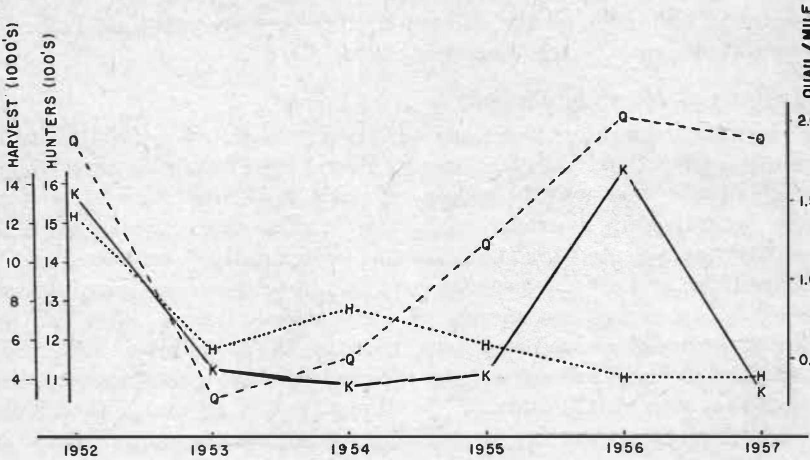

Figure 3. Relationship of scaled quail population, hunting pressure and total harvest in the Trans-Pecos Region.

purchasing a license. From field checks made in 1953 we found that approximately 75 per cent of the bird hunters have licenses. On this basis the estimates of total quail hunters might be corrected to a range of about 1,400 to 1,900 in the past six seasons. This represents a density of about one hunter for each 10,000 acres of quail range. Studies of valley quail (Glading and Saarni, 1944) and Gambel quail (Swank and Gallizioli, *op. cit.*) indicate that hunting, even at higher intensities than we experience in the Trans-Pecos Region, does not exert a significant influence on the population. We feel that the conclusion that the influence of hunting pressure is self-regulated by the quail population level for each year can be extended to scaled quail. Although no comparable studies of hunting influences have been made, the species is probably the most difficult to hunt of all our quails.

In the Trans-Pecos Region there are a few areas where quail hunting is reasonably intensive, but considering the whole area it is probably safe to say that over 99 per cent of the birds never see a hunter. Certain characteristics of the distribution of the human population and of hunting pressure are illustrated in Figure 4. These data were taken from the 1952 hunting season. Comparison of two of the counties provides an example of the anomalous situations that exist. Brewster County, comprising 20 per cent of the area of the region, had only three per cent of the human population but 16 per cent of the scaled quail hunters. El Paso County, with 80 per cent of the human population, accounted for only 28 per cent of the quail hunters. Its area is only about three per cent of the total, approximately one-sixth the size of Brewster County.

In 1952, when the preceding data were obtained, there was a relatively uniform, moderately high quail population over the region. In 1957 the regional average population was high, but in El Paso County it was very low. The estimated total kill dropped 78 per cent from 1956. Only a small percentage of the total hunting area was involved, but a very large percentage of the hunting population was affected.

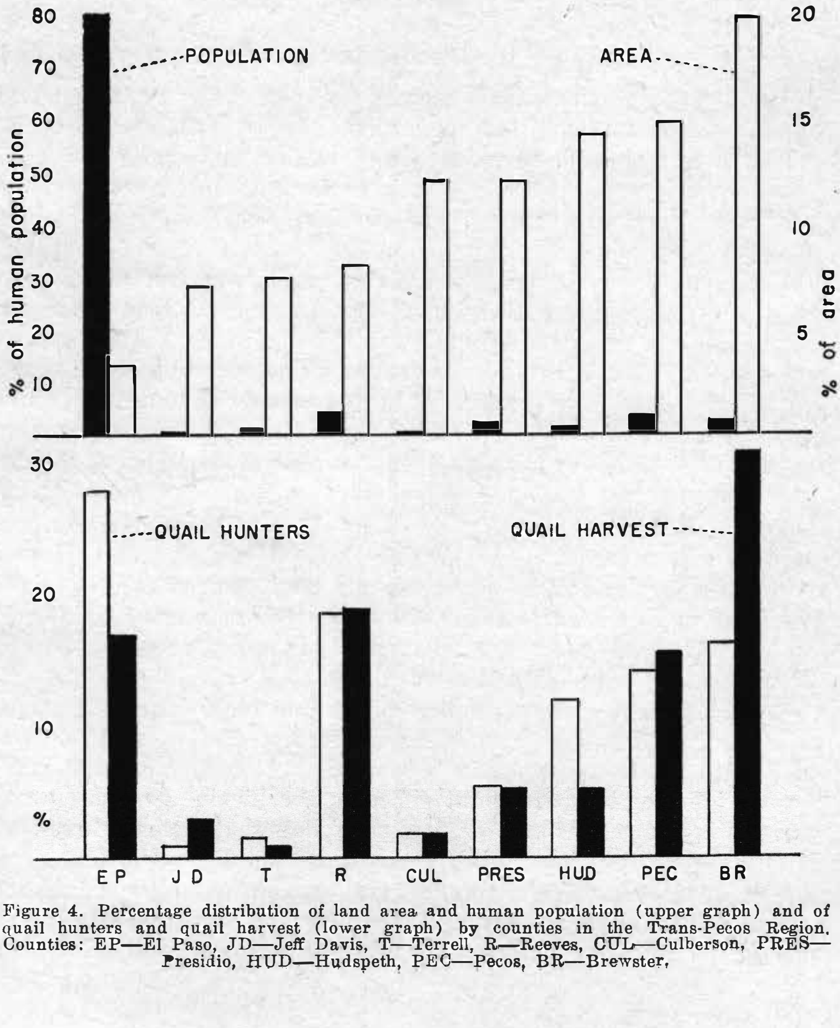

Figure 4. Percentage distribution of land area and human population (upper graph) and of quail hunters and quail harvest (lower graph) by counties in the Trans-Pecos Region. Counties: EP—El Paso, JD—Jeff Davis, T—Terrell, R—Reeves, CUL—Culberson, PRES—Presidio, HUD—Hudspeth, PEC—Pecos, BR—Brewster.

A comparison of El Paso County (a big city-small farm area), Reeves County (a small city-big farm area), and Brewster County (a small town-big ranch area) is enlightening. Reeves County, with roughly five per cent of the human population, provided 19 per cent of the quail hunters and 19 per cent of the total kill. It is a major farming area; 16 per cent of the population (11,745 people in 1950) is rural, living on farms and ranches (Skrabanek, 1955). Hunting space is available to them. In Brewster County, an area of large ranches, only about eight per cent of the 7,309 people (1950 census) is rural. El Paso has the largest rural population but it constitutes less than five per cent of the total human population of 200,000.

DISCUSSION

The preceding facts explain some of the obstacles in the path of the game manager's attempt to accomplish effective public service. No matter how successful we might be in raising and stabilizing quail populations it would contribute little to the solution of these primary problems. There are many special problems that have not yet been adequately explored.

For example, we are aware that scaled quail, being more difficult to hunt, are not as popular as bobwhites. If hunting space were unrestricted, how many more hunters would turn out? Since distances are great in West Texas, how far would people travel to hunt scaled quail? Most landowners, naturally, are not receptive to armed strangers. What kind of economic return, cooperative management, or other persuasion would be required to open a considerable number of ranches to hunting?

The conditions observed in the Trans-Pecos Region of Texas are applicable to most of the geographic range of scaled quail. Human population levels, land-use practices, and quail ecology are essentially the same in New Mexico and Arizona, as well as parts of Colorado and Oklahoma, so the same problems apply in some degree to well over 200,000 square miles of the United States.

Similar problems exist in other species and other areas. Deer constitute a good example; also, collared peccary. Yet we find that our profession tends to emphasize research on biological aspects while largely ignoring the paramount difficulty of achieving adequate use of the existing game resource. It does not follow that biological research is unnecessary, but it certainly needs to be supplemented.

The fact is that we do not understand the consumer (the actual and potential hunting population) and the producer (the landowner) well enough to make use of our knowledge of the commodity. We can profitably borrow from the intensive production and marketing analyses that are made in other fields.

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DISCUSSION

CHAIRMAN STOKES: We have had quite a water development program in these dry areas. Just producing water holes will not merely produce green vegetation in the drought areas. What is the relationship between the development of water areas and quail or chukar numbers?

MR. WALLMO [Texas]: I would like to say that you can develop all the water you want and you won't grow quail. We carried on water studies near El Paso and in the Big Bend country. I think you can say, for the desert quail and some of the other quail, that they drink water and that is just about as far as you can go.

In the Big Bend area we have considerable areas where there is no free drinking water of any kind. As nearly as we can tell, there is no correlation between water availability and population size.

DR. WENDELL SWANK [Arizona]: We are making an evaluation study to see if we are getting our money's worth in connection with water areas and perhaps nine years hence we will be able to give you an answer.

MR. FRANK GROVES [Nevada]: I hate to start an argument here but our findings on quail in southern Nevada indicate that water catch basins are effective. It is true that they do not reach all of the quail, but we have found that it allows a population to hold over during the drought periods and they then have a much faster recovery rate when food conditions are right.

MR. JACOBS [Oklahoma]: Have you found any relationship between your spring and fall populations?

MR. WALLMO: The area that I am most familiar with is relatively small with a small number of birds. However, it involves all the birds and all that are marked. I have partial data for four or five years but only complete data for three years. Initially I had 150 birds to work with and the population dropped the next year to slightly less than 100 birds. Then, with that extremely low population, with a period of high spring rainfall, I got the highest population of that three-year period. In other words, the young to adult ratio varied from 0.3 to 3.9 the following year. That younger adult ratio applied to winter birds.

Our data have supported the fact that if we get good winter and spring rains we are going to have more quail and so, knowing that, we can go ahead and hunt them. We also realize that this is somewhat silly because we have already got more quail than we can hunt. It really doesn't make any difference.

DR. BUSS [Washington]: I think that it is a little dangerous to draw broad generalizations or hard-and-fast ones at the relatively early stage of research in connection with this subject matter.

With regard to pheasants, it has been reported that 1957 saw one of the highest and best populations of pheasants that the State of Washington has had for many years, and this followed the lowest year that we have had insofar as spring population is concerned for ten years.

MR. KIRK [Michigan Dept. of Conservation]: It seems as if the fall and winter hunting in the West could be better solved by the Chambers of Commerce of those States. Therefore, is there any campaign on to entice hunters to come to those areas?

MR. WALLMO: We have got some problems in Texas that really are knotty. I refer to private land and, of course, Texas has had a different history from most of the western states. I believe that hunting has been commercialized in Texas to a degree that hasn't been realized by any other state.

In the case of deer, we have some pretty good basis for planning management on economic grounds. A buck is worth $50, $100 or $150, depending upon his proximity to the hunting areas and according to the type of range and so on and, in addition to that, we can assess the deer in terms of his influence on the ranchman as a grazing animal. The result is that we do have data that can tell the ranchman what this animal unit of deer is worth to him and then he can turn around and ask himself whether he wants to hunt it for that price or merely put up with them.

The reason that I bring this up is because people will not travel 200 or 300 miles to hunt quail and so you have to go that far in order to get them started.

I don't think that at the present time the chambers of commerce can help us much because we don't have the information to help them. We have got to develop it ourselves and that is why I say I think it will be profitable for us to turn to a production and marketing type of research, in order to help the people we are working for.

THE EFFECTS OF DROUGHT AND HUNTING ON THE CHUKAR PARTRIDGE[1]

GLEN C. CHRISTENSEN

Nevada Fish and Game Commission, Reno

Since habitat of the chukar partridge is characterized by the arid nature of the climate it is only natural that this species will be confronted from time to time with drought. Nevada's ranges are now recovering from a drought which began in 1953 and lasted through 1955. The drought was severe and the results were devastating. However, it did afford us the opportunity of seeing how the chukar partridge would respond when put to one of nature's most merciless tests.

In 1951 and 1952 the chukar populations in Nevada were at their highest known peak. In 1953 there was a noticeable population decline to be followed by a drastic crash during the years of 1954 and 1955 and a recovery in 1956 and 1957. Field observations were made of range and food conditions throughout this period. These observations show that there is a definite correlation between range conditions and chukar production.

THE EFFECTS OF DROUGHT

In 1951 range conditions throughout most of the chukar habitat in the state were excellent. During the months of March, April and May the mountain slopes were a carpet of grasses and annual and perennial plants. By the end of March red-stem filaree (*Erodium cicutarium*) was in full bloom and by late April most of the grasses had headed out and numerous other flowers were in bloom. Insects were abundant. This was a good food year throughout the spring, summer and fall, and by November green food was available again in the form of winter germinating grasses. Similar conditions prevailed in 1952 and both 1951 and 1952 were excellent production years for the chukar. In 1953 the vegetation was not as profuse, the beginning of a drought was noticeable, and chukar production dropped off. There was a conspicuous lack of green grasses during the fall and winter of 1953-54, and during the spring of 1954 the hot days and winds seared the plant crop before there was a chance to seed. With exception of a few isolated areas, where local thundershowers carried the crop through, dust bowl conditions prevailed. The insect life had vanished, and the chukar population reached an all-time low. Range conditions improved slightly in 1955 and there was a corresponding minor upsurge in chukar production. The winter of 1955-56 was a good one, followed by frequent

[1]A contribution from Federal Aid in Wildlife Management Restoration Project W-8-R, Nevada.

spring showers which resulted in the best food crop since 1952. Similar conditions prevailed through 1957 which in many respects was an even better food year. The chukars, responding to the improved conditions, made a remarkable comeback.

An analysis of the food habits of the chukar partridge (Christensen, 1954; Galbreath and Moreland, 1953; Harper, Harry and Bailey, 1958) shows that they depend upon the green leaves of the winter germinating plants, notably cheatgrass (*Bromus tectorum*) and bluegrass (*Poa* sp.) to carry them through the late fall, winter and early spring periods. During the spring, summer and early fall, seeds make up the bulk of their diet.

Table 1 shows the precipitation and adult/young ratios for Reno, Mina and the State over a seven-year period. The area surrounding Reno is considered typical of the prime chukar habitat in the state. The area adjacent to Mina is representative of the more arid districts in the southern range of the chukar distribution.

The precipitation which is recorded does not represent that which fell during a calendar year; instead, in order to follow the precipitation pattern in relationship to plant growth, a year is considered as being the period from September through August. Therefore the 1951 precipitation figure represents the total which fell from September 1950 through August 1951, etc.

In reviewing the table the general trend of reduced chukar production in conjunction with a decrease in precipitation is apparent. The one exception occurred in 1957 when, even though there was a decrease in precipitation and the adult/young ratio, an exceptionally good food year still materialized. In fact range conditions during this year were even better than in 1956. It is believed that the decline in production for 1957 can be attributed to a large carry-over of 1956 birds and reflects a levelling-off of the population. Actually the adult/young ratio found in 1957 is fundamentally very good and would appear to be closer to a normal condition than the higher ratios obtained during 1951 and 1952. Also, it should be noticed that the average brood size was still at a high level. During the 1957 survey it was apparent that the chukar population was near the all-time high of 1951 and 1952.

For the most part the drought was general throughout the state from 1953 through 1955. However, in some areas local thunder-showers and unique precipitation patterns resulted in favorable food years during the general drought. This was noticed mainly in the more arid areas near the southern extremity of the chukar distribution. The data presented for Mineral county in Table 1 illustrates how rapidly

TABLE 1. PRECIPITATION AND ADULT/YOUNG RATIOS FOR WASHOE CO., MINERAL CO. AND STATE[1]

	Washoe County			Mineral County			State			
Year	Precipitation (Reno)	Total birds classified	Ad/Yg ratio	Precipitation (Mina)	Total birds classified	Ad/Yg ratio	Precipitation (State average)	Total birds classified	Ad/Yg ratio	Average Brood Size
1951	9.50	332	100/876	5.25	No survey	....	8.46	332	100/876	..
1952	10.89	343	100/757	6.46	0	Good[2]	10.86	776	100/743	11.5
1953	7.02	199	100/63	1.19	0	....	5.91	641	100/42	6.0
1954	5.15	166	100/11	4.47	123	100/515	5.88	665	100/106	6.6
1955	5.30	20	....	3.52	44	....	6.87	535	100/207	7.9
1956	10.92	176	100/877	5.34	156	100/953	8.48	1,553	100/509	14.0
1957	4.68	1,012	100/310	3.60	160	100/290	7.77	3,908	100/418	11.2

[1]The total precipitation (based on U. S. Weather Bureau records) received during the period from September through August constitutes a year. The year 1951 therefore represents the precipitation, in inches, received from September 1950 through August 1951, etc.

[2]Excellent populations observed but surveys too late to classify birds.

TABLE 2. COMPARISON OF CHUKAR KILL[1] INFORMATION, AND ADULT/YOUNG RATIOS FROM SUMMER SURVEYS, FOR DISTRICTS I AND II.

	District I				District II				
Year	Ad/Yg ratios	Percent State kill	Hunter days	Birds per hunter day	Ad/Yg ratios	Percent State kill	Hunter days	Birds per hunter day	TOTAL STATE KILL
1951	....	18	2,500	2.5	....	82	10,200	2.9	36,100
1952	....	24	4,345	2.4	....	76	16,000	2.0	43,700
1953	100/49	52	4,357	2.1	100/40	48	7,000	1.2	18,000
1954	100/62	....	....	....	100/122	....	....	....	Closed
1955	100/162	95	418	2.5	100/227	All major counties closed			1,100
1956	100/627	63	3,190	2.5	100/450	37	3,190	1.4	12,600

[1]Based on questionnaire sent to 10% of all licensed hunters in Nevada.

chukar production can fluctuate from year to year. At the beginning of the drought in 1953 chukar production in Mineral county was apparently at a standstill. In fact, extensive surveys had failed to turn up a single bird. Yet in 1954, when the populations were hitting bottom in the remainder of the state, there was an increase in precipitation which produced a food crop and resulted in a decided increase in production in the Mineral County areas. This was followed by another decline in 1955 and an enormous upsurge in 1956. The moisture needed to put off a food crop is surprisingly little if received at the proper time. This is well illustrated by the Mina records which show that good chukar populations can be produced when the range receives approximately four inches of precipitation.

In the final analysis it is apparent that the total precipitation received during a year is not indicative of the entire picture. Unfortunately there is little data presented in regard to the effects of evaporation from both the sun and the ever present winds. Winter snows, which may add considerably to the total precipitation figure, are often blown away or evaporated without penetrating the frozen soil. Local thunder-showers are not recorded, nor do we know the exact relationship between plant growth and dew. For these factors we do not have an accurate measure, but the end result, based on statewide range and brood surveys, shows that there is definite correlation between precipitation, range conditions and chukar reproduction.

CENSUS METHODS

In Nevada the upland game seasons are set during the first part of August; therefore all surveys and recommendations must be completed by the end of July, Actually the month of August could be used advantgeously for the surveys since by this time the young birds are fairly well grown, still distinguishable from the adults, are easier to observe and are concentrated to a greater extent around the watering sites. Similar results can be obtained in July, but often it is necessary to run the surveys up to the last day.

In obtaining the chukar brood counts and adult/young ratios two methods are employed: (1) waterhole counts and (2) transects. The surveys are designed so that each waterhole and transect count is made twice, once in June and again in July. In 1951 the surveys were restricted to the Pyramid lake area near Reno. In 1952 most of the effort was directed towards scouting out suitable survey areas on a statewide basis. During 1953 through 1957 the same areas were worked each year, with some variation due to expansion of the program.

Our experience shows that the early surveys (June) seldom provide us with a sample as large as that obtained during the late surveys

(July). The reason for this is that the chicks are usually less than a month old, are not concentrated, and consequently much more difficult to find. Observations during 1956 and 1957 indicate that some of the chukars have not even completed the hatch at the time of the first survey. The primary importance of this survey has been to determine a relatively accurate brood size and to get the men acquainted with the survey areas.

The July survey comes during a time when the birds are larger, less secretive and tending to concentrate more around the watering areas. This survey produces a larger sample; however, in many instances it is not possible to determine brood size due to banding together of the chukar broods. Therefore the importance of this survey is to determine the adult/young ratio, which should be based on as large a sample as possible.

The waterhole counts are limited to small springs or seeps, at which all approach lanes can be adequately observed by one individual. The observations are made from a vehicle or blind which is close enough to the waterhole to permit an accurate count. Observations commence just prior to sunrise and continue until the morning watering activity stops. There is some variation in the time which the chukars water and this must be determined from year to year.

The road transects are made in areas where it is not possible to obtain waterhole counts. The vehicle is driven slow enough to allow for adequate observation and when birds are seen the vehicle is stopped so an accurate count can be made. In some instances walking transects are made into areas where it is not possible to take a vehicle. These transects are along water courses or to springs which are located off the road.

None of the chukar transects have been rigidly standardized. It has been found that in order to obtain a sample of sufficient size to be reliable the methods must be flexible enough to fit in with this species' somewhat erratic pattern. The very nature of a waterhole count fairly well standardizes that method, but waterholes which can be satisfactorily used for counts are limited. Therefore, in order to obtain representative counts for the entire state and to secure a workable sample, road and walking transects must also be used. The primary tool in regard to successful transects has been to know the area well enough to find the birds. Transects have been made through an area without seeing a bird. Yet the next day, covering the same area under comparable conditions, a large number would be found. Due to the nature of the terrain which the chukar inhabits, and the fact that standardized transect methods have so far proven to be unreliable, there has been no attempt to compute the population density. However, the population trend is apparent when the survey figures are compiled. The adult/young ratio measures the production. The ease of finding the birds, the total number of birds seen, and familiarity with the areas worked gives information as to the status of the population.

Chukar chicks commonly band together after they are a few weeks old. This is especially noticeable during good production years and it is not uncommon to see bands of 30 to 50 or more chicks. During field observations in 1957 several instances of banding, or adoption, were noticed at waterholes. On one occasion it was observed that a hen which came to water with 7 chicks left with 4, while another hen which came in with 11 chicks left with 14. The waterholes are a veritable mixing bowl for the young, and in this respect the brood counts which are taken after the birds start concentrating at the watering sites are subject to considerable suspicion. Similar conclusions were reached by Harper, Harry and Bailey (1958) during their studies in California.

RANGE EVALUATION

The condition of the range is a key to what may be expected in regard to chukar reproduction. By proper range evaluation it is possible to predict, within limits, the success of the current year's reproduction. In order to have a well rounded chukar program it is essential that periodic range evaluation be made the year around. The primary concern is to see if the grass crop starts to germinate by late fall so that a winter food supply is available, to observe if this crop is maintained during the winter months, and if it and the spring annuals and perennials mature during the spring and summer months.

Chukars do not lend themselves well to winter and early spring surveys and during these periods the condition of the range is a good indicator of how well the birds are doing. Range evaluations plus summer brood survey and classification data in conjunction with past hunter kill records provide adequate information upon which to base season recommendations.

HUNTING

The first chukar hunting in Nevada was a two-day season held in November 1947. Seasons have been held in various counties of the state during each succeeding year, with the exception of 1954. Only two counties, Clark and Lincoln, do not have established chukar populations.

No kill records are available for the years 1947 through 1950. However, in analyzing the state kill records from 1951 through 1956

(Table 2) it can be seen that the kill correlates closely with the adult/young ratios which were obtained on the summer surveys. During the good production years of 1951 and 1952 a high kill was obtained. In 1953 the kill figure declined by nearly 60% and the harvest which was obtained was composed mainly of adult birds which were carried over from 1952. During 1953 eight counties made an emergency season closure. The birds were so scarce and hard to find in 1954 that the season was closed statewide. A slight increase in production was noted in 1955 and four counties held an open season. The kill was very low. In 1956 there was good production and 13 counties were opened. The kill, though moderate, reflected the surprising comeback of the chukar. In 1957 the adult/young ratio showed a decline; however, the counts were exceptionally high and 15 counties opened a season. The 1957 kill figure is not yet available, but it is expected to be more than double the 1956 harvest.

Hunting during a population low—Of the fifteen counties which have established chukar populations, Pershing, Humboldt and Lander have had the most consistent liberal seasons. In these counties, which will be referred to as District I, there has been only one closed season (1954) during the period of 1951 through 1957. The season lengths within this district have varied with the individual county, but as can be seen from Table 3 have generally been long ones.

The remaining counties of the state, which comprise District II, have for the most part had less generous seasons. Also, all of these counties were closed for at least a two-year period during the drought. Nye county, which started out with extremely liberal seasons, has not

TABLE 3. HUNTING SEASON LENGTHS, IN DAYS, FROM 1951 THROUGH 1957.

	1951	1952	1953	1954	1955	1956	1957
DISTRICT I							
Humboldt	15	62	57	0	29	57	64
Lander	62	78	64	0	29	57	64
Pershing	62	62	82[1]	0	29	57	64
DISTRICT II							
Churchill	62	33	18	0	0	8	22
Douglas	0	30	18	0	0	8	15
Elko	0	0	0	0	15	15	22
Esmeralda	32	78	18	0	0	15	15
Eureka	7	8	64	0	0	15	64
Lyon	32	30	18	0	0	8	15
Mineral	32	36	18	0	0	15	15
Nye	36	78	64	0	0	0	15[2]
Ormsby	32	30	18	0	0	8	15
Storey	32	30	18	0	0	8	7
Washoe	32	30	18	0	0	8[2]	22
White Pine	2	2	2	0	0	15	15[2]

[1]Bag and possession limit in all counties was 5 birds daily and in possession with the exception of Pershing county in 1953 where it was 5 birds daily and 15 in possession after the second day.

[2]Only minor portions of these counties open during years indicated.

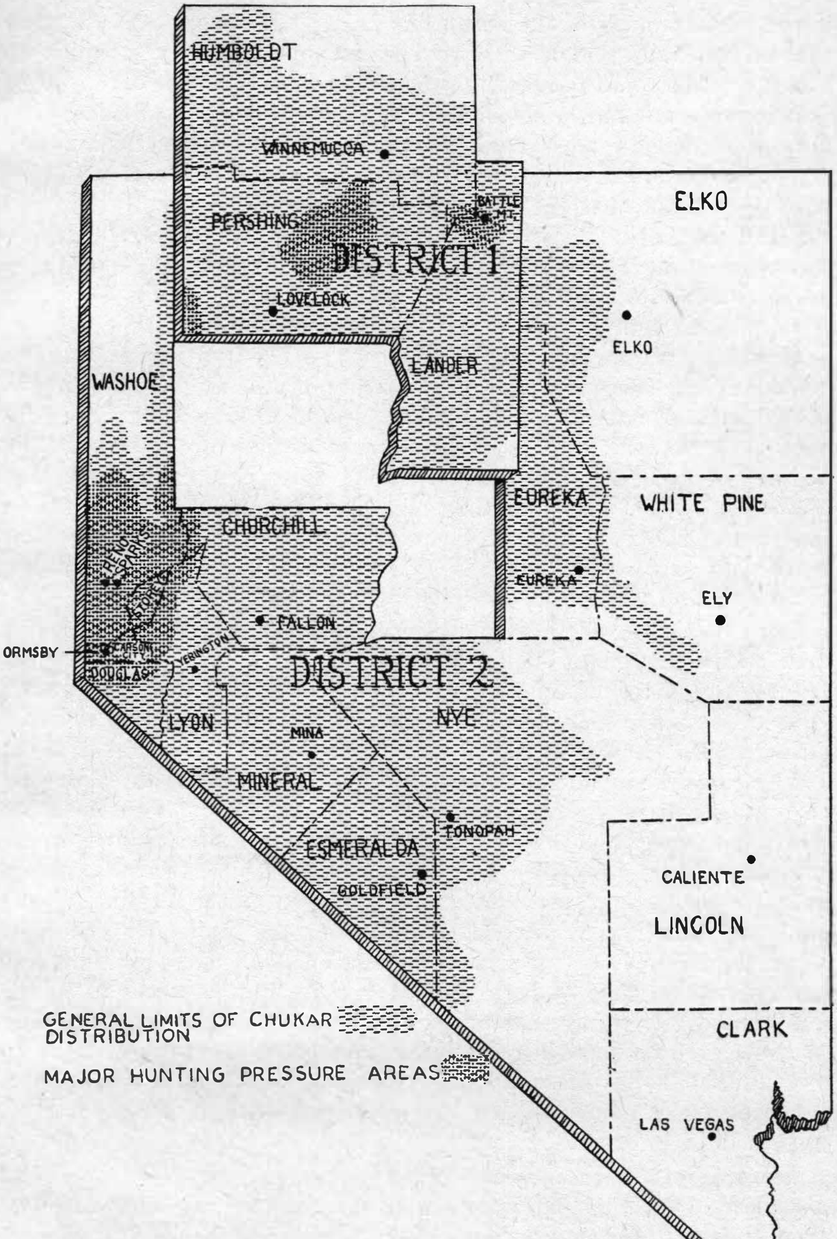
been re-opened to hunting (except for the small northwestern corner) since its closure in 1954.

The counties which comprise Districts I and II, the general chukar distribution limits, and the hunting pressure areas of the state are shown in Figure 1.

Table 2 depicts the percentage of the state chukar kill in each of the two districts. During 1951 and 1952 District II accounted for the majority of the chukar kill in the state. The seasons were not as long as those in District I; however, the large centers of population (Reno and Sparks), and therefore the bulk of the hunting pressure, are located in this district.

In 1953 the chukars were not as easy to find and the hunters began to scout out new hunting sites. The emergency closure (ater only 18 days) in most of District II caused many hunters to go into District I. The majority of these hunters went to Pershing county, where a 15-bird possession limit was in effect. Since this time Pershing county has been one of the heaviest hunted counties in the state.

From the period of 1951 through 1956 the birds killed per hunter day in District I have remained close to 2.5. This occurred even during the drought period and in conjunction with long seasons. In District II there was a sharp decline in birds per hunter day in 1953, and following a two-year closure the birds taken per hunter day in 1956 were significantly lower than that of District I despite the fact that the number of hunter days in each district was the same. During this year most of Washoe county was closed. Since this is one of the major chukar producing counties in District II it would account partially for the lower kill. The short season in District II, which was limited to only eight days in the major hunting areas, also would account considerably towards the reduced kill. In addition the opening week of the 1956 chukar season was preceded by several good rains. The birds were scattered and hard to find. Actually the best hunting occurred later in the season, following the closure of District II, when weather conditions were more suitable. In District II the hunters concentrate within a short radius of Reno, Sparks, Carson City and Yerington. The chukar populations in the remainder of the district are always underharvested due to the lack of hunters. In District I there was less competition over a longer period of time. In many instances each hunting party could have the privilege of hunting a watering site, canyon or mountain range to itself. Furthermore, it is becoming apparent that people who go into District I, which often necessitates considerable travel, are more determined hunters and persist until they obtain some birds. In contrast, as is common around most large popu-


HUMBOLDT
WINNEMUCCA
PERSHING
BATTLE MT.
DISTRICT 1
LOVELOCK
ELKO
ELKO
LANDER
WASHOE
EUREKA
WHITE PINE
CHURCHILL
RENO
SPARKS
EUREKA
ELY
FALLON
ORMSBY
CARSON CITY
DOUGLAS
YERINGTON
DISTRICT 2
LYON
NYE
MINA
MINERAL
TONOPAH
ESMERALDA
GOLDFIELD
CALIENTE
LINCOLN
CLARK
LAS VEGAS
GENERAL LIMITS OF CHUKAR DISTRIBUTION
MAJOR HUNTING PRESSURE AREAS

lation centers, many of the hunters in District II simply make a quick tour of the local areas in their vehicles in hope that they can pick up a bird or two from the road.

It is evident from the district adult/young ratios and kill data that despite consistent long seasons, the opening of a season during a period of population crash, and in one instance the presentation of a 15-bird possession limit, that the chukar populations in District I have not suffered a setback. The populations in this district recovered quickly when the drought was broken in 1956, are now providing the major portion of the state kill, and with a more liberal season this district is providing the hunters with greater success per hunter day.

Hunting pressure and length of season — The hunting pressure in Nevada is extremely low when compared with upland game hunting in other states. During the peak chukar sceason (1952) there were only about 7,000 chukar hunters in the state. This figure represented 20% of the total licensed hunters. For the most part, with exception of the Clark, Lincoln and White Pine county residents, most hunting has been of a local nature. Great portions of Nevada's chukar habitat in the sparsely settled counties (Mineral, Esmeralda, Nye, Lander, Humboldt and Churchill) are relatively unhunted.

Our experience with heavy hunting pressure has been limited to the area which surrounds Reno, Sparks, Carson City and Yerington. During the 32-day season in 1951 a total of 25,000 birds, or nearly 70% of the state kill, were harvested in the area adjacent to these cities. In 1952 a total of 22,000 birds were taken in the same area. In 1953 the decline in chukar production and density in this area, drastic as it was, was no different than that observed throughout the state where the drought had taken effect. This included many ranges where previous hunting pressure was almost insignificant. To all appearances, regardless of previous hunting pressure, the decline of the chukar population was general throughout the state. By the same token the recovery of the chukar populations, when the drought was broken, was as good or better in the heavily hunted areas as in the non-hunted. It seems that under the present conditions of hunting pressure even the most heavily hunted regions of the state can bear up well under a 30-day season. In the remainder of the state, where hunting pressure is moderate, low and even non-existent, longer seasons appear to be in order.

When to set the season—During the past seven years Nevada has had a variety of opening dates for the chukar season which have ranged from the third weekend in September to the third weekend in November. The opening date of the season can be of great importance in determining the harvest. Although it is not possible to predict the weather, September and early October openings usually find the birds concentrated at the watering sites and the hunting is much easier. Late October and November openings will usually find the birds scattered and more difficult to locate. As the season progresses through November and December the birds are increasingly difficult to find.

A September opening has generally been undesirable, the primary objection being the relatively large number of small birds which are taken during the first few weeks. Late hatch birds appear to be prevalent, especially during the good production years, and many of them are only three-quarters grown by the time the September season occurs. To prevent this a mid-October opening would appear to be about right. However, due to lack of hunting pressure in most of the state, this could result in a considerably reduced harvest. Therefore, a season opening during the first part of October appears to be satisfactory for most areas.

The opening date and season length can be used as a management tool to give the hunter incentive to go to the more remote and less populated counties which could have an early opening and long season, while the season can be shorter and at a later date in the major pressure areas. During bumper production years when a large harvest is desirable an early season is in order. During poor production years the opening date can be later in order to avoid waterhole shooting.

MANAGEMENT RECOMMENDATIONS

It is evident that the condition of the range is one of the most important factors in determining chukar production. Of primary importance is the necessity of having green grasses available for feed and conditioning during the winter and early spring months. It is felt that the precipitation pattern and effectiveness through the period of September through August is a major factor in determining range conditions and consequently chukar production. Additional studies in regard to the relationship of soil moisture and plant growth during this period are needed.

Generally the hunting pressure in Nevada is low. The major hunting areas have been near the large centers of population. In an effort to obtain a more uniform hunter distribution and kill throughout the state it is believed that season manipulation can be of considerable value. In this regard a later opening date and shorter season can be held in the problem areas while an earlier opening date and longer season, in conjunction with a larger bag or possession limit, should be recommended for the outlying areas.

Although our present information indicates that hunting pressure has had no serious effect on the chukar population our experience in dealing with heavy hunting pressure is limited. It is entirely possible that early seasons, which invite waterhole shooting, can be dangerous in local areas. Additional research should be directed along these lines.

The opening of September seasons is objectionable due to the size and vulnerability of the birds. No season should be held earlier than the first week of October. The length of the season apparently has had little effect on the populations although during the past two years there is an indication that many hunters are beginning to become more persistent and successful during the latter part of the season. The values of late season hunting should be pointed out and encouraged while at the same time the early opening dates should be discouraged unless necessary to obtain the desired harvest.

SUMMARY

The precipitation pattern and effectiveness has a direct bearing upon the annual food crop which is produced in chukar habitat. The condition of the range follows in turn as the determining factor in chukar production. During a three-year drought in Nevada there was a decided decrease in chukar production and decline in population. With the advent of proper range conditions the populations made a quick recovery.

To all indications the holding of a hunting season during a period of population low has no important depressive effect upon the chukar population. The advisability, and success, of holding such a season depends greatly upon public acceptance. Areas in Nevada which held chukar seasons during the drought period recovered as quickly as those which did not have seasons, and these areas are now providing the bulk of the state harvest.

Under the present conditions of hunting pressure in Nevada it seems that even the most heavily hunted regions of the state can bear up well under a 30-day season. Longer seasons and larger bag or possession limits are justified in the outlying regions of the state.

October opening dates are generally recommended. September seasons are objectionable due to the small size and vulnerability of the birds, while November opening dates materially reduce the harvest.

ACKNOWLEDGMENTS

During the period of this study nearly all of the staff of the Nevada Fish and Game Commission, and many of the Commissioners and County Game Board members, have contributed in one way or another towards the progress of the chukar project. Without reservation I extend my deep appreciation to each of them. For their extra keen interest, companionship and aid in the field, and review of this manuscript I am especially indebted to Glen K. Griffith, Joseph C. Greenley, Nils N. Nilsson, Gordon Gullion, San Millazzo, Charles W. Crunden and Bill Foree of the Commission, and to Dr. Ira La Rivers of the University of Nevada.

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TECHNICAL SESSIONS

Tuesday Morning—March 4

Chairman: EDWARD C. RANEY
Professor, Department of Conservation, Cornell University, Ithaca, New York

Discussion Leader: WILLIAM E. FAHY
Associate Professor, University of North Carolina, Institute of Fisheries Research, Morehead City, North Carolina

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MARINE AND COASTAL RESOURCES

IRREVERSIBLE DRAINAGE—A NEW FACTOR IN WATERFOWL MANAGEMENT

WILLIAM W. NEELY
Biologist, Soil Conservation Service, Walterboro, S. C.

Drainage is often a paradox. Most of it does not affect waterfowl. Some of it does. Drainage is a necessary part of water control for the better management of land to benefit waterfowl. On most soils, drained areas can be converted from agronomic use to wildlife use when the land manager chooses this alternative. However, recent investigations by Soil Conservation Service in cooperation with the Agricultural Research Service have identified a band of coastal soils stretching from New Jersey to Texas which, when once drained and dried, become barren after a few years. Such lands cannot be readily converted to their original condition by restoring water. The drainage is irreversible. It is probable that a similar condition exists in other coastal marshes of North America.

This fact is as important to the wildlife technician who plans the use of these lands for growing waterfowl foods, as to the landowner who might also have agronomic interests in them. Both need to be careful that irreversible conditions are not created which may ruin the land for an undetermined period of years.

Upon drainage and drying, a reaction takes place in some coastal soils which has not been generally recognized in the United States (Edelman and van Staveren, 1958) (Green, 1957). This is the formation in the soil of a basic ferric sulfate and sulfuric acid. The Dutch call such soils *katteklei* (cat's clay). Even with their many years of experience with wetlands, they hesitate to attempt any high degree of development of such lands. (The famous Zuider Zee area of the Netherlands is a different type of soil.)

Many of the brackish marshes and old rice fields of the east and southeast contain these cat clays. Even in early 1957, areas like these were looked upon as future breadbaskets of the Nation in light of expanding population. Now we know that extreme caution is needed for proper use of these lands.

These cat clays develop when sea water regularly or occasionally floods soils which 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 iron sulfides. Some of these are apparently complex polysulfides. As long as the soil remains wet, the sulfides continue to exist in that form and the soil usually is only slightly acid.

However, under the aerobic conditions which come about when the soils are drained, the sulfides oxidize. There are many reactions, but the general one is:

$$\text{polysulfides} + \text{oxygen} \rightarrow \text{sulfates} + \text{sulfuric acid}$$

In mild cases, the pH of the soil may drop from about six to around four within five years after being drained. In extreme cases, the drop in pH is from about six to 2.5 or below. Then neither crops, pasture, nor duck foods will grow. Enormous applications of lime — perhaps exceeding 50 tons per acre in some cases—would be required even for temporary relief.

In the original condition of the soil it may be difficult to determine the presence of sulfides by simple observation. Sometimes the wet subsoil will exhibit a bluish-black sheen, but chemical tests may be necessary to make a positive identification. On air drying, a drop in pH and in the content of non-sulfate sulfur are diagnostic properties.

Agricultural Use

Rice culture was possible in the coastal wetlands of the southeast because it was a crop which did not require deep drainage or drying of the soil. Since the fields were flooded or kept in wet condition for most of the year, sulfide oxidation did not take place.

Except for a rice-type of agriculture, soil scientists agree that use of the high sulfur, brackish-marsh areas with cat clay soils will be limited to management for native range forage or for fish and wetland wildlife. One of the better grazing plants for livestock is marshhay cordgrass (*Spartina patens*). There is still not enough experience to be certain of the natural development of dominant stands of this grass. However, this usually occurs in areas with a salinity range of 10,000 to 25,000 ppm, which are diked and the water table lowered one to four inches below the ground surface. Since the soil will remain wet under these condtions, sulfide oxidation will not take place. Field studies are under way to evaluate "greened up" marshhay cordgrass (by late summer burning) as winter grazing for wild geese.

BIOLOGY FIELD STUDIES

Unfortunately, some landowners have drained cat clay soils to make cropland or improved pasture. This eventually presents the problem of how to reclaim areas of this sort. 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 upon 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. There is so much acid-forming material that the buffering action of brackish water is of little avail.

Field studies are now being made to determine if this condition can be corrected by repeated impoundment and draining. The thought behind this is that repeated applications of water may exhaust the acid-forming material. At first it was believed that one or two changes of water might accomplish this. However, it has proven more difficult. Further, without an economical source of water, this method would not be practical.

A typical example is one located along the Ashepoo river in Colleton County, South Carolina. Until 1951, this 150-acre field was brackish tidal marsh with a dominant stand of needlerush (*Juncus roemerianus*). The landowner then diked and drained it to make permanent improved pasture. Salinity was not considered a hazard since normal rainfall in this region would leach the salt from diked areas in two or three years sufficiently to grow adapted grasses such as fescue. By the summer of 1956, the pasture had failed because of the then unrecognized change in soil chemistry. At that time the landowner applied to the local Soil Conservation District for SCS technical assistance to make the field into a waterfowl area. Because a convenient source of brackish water was available from the tidal fluctuation of the Ashepoo river, a widgeongrass pond was recommended as the most practical land use. Suitable water control structures were installed and brackish water 24-30 inches deep was impounded over the field. Widgeongrass was introduced by scattered plantings. There seemed no reason why this would not become an excellent duck field. Six months later, however, the widgeongrass had disappeared. Something was wrong—but what?

Not until our current knowledge of the nature of cat clays was developed was it clear what had happened. When the water in the impoundment was examined in August 1957, the salinity was about 11,000 ppm but the pH of the water was 2.5! Little wonder the planted widgeongrass had disappeared.

In early September 1957, field studies on repeated draining and impounding were begun. The original water was drained and two complete changes of water were made by November 1. The pH was then 3.0—an insignificant improvement. By February 1, 1958, after four changes of water, the pH was still 3.0.

Four similar fields are included in our current study. The history of each field is a duplication of the one previously described. An almost continuous flow of brackish water through a 12 inch pipe is being run through one pond of about 100 acres. This is possible because of a peculiarity in location in respect to tidal intake points. The original pH of the water in the impoundment was 3.0; at the end of four months of the above flow it was 3.5. It is planned to keep another of these fields flooded and with no change of water (if the landowner doesn't become too impatient!). The other two fields are being treated by repeated draining and impoundment.

Immediately adjacent to two of these sites, successful widgeongrass ponds were constructed on marshes which had not been drained and dried. The pH of the water in these, as well as all the water tested from other successful widgeongrass ponds constructed on undried saline marshes, ranges from 7.0 to 8.0.

MANAGEMENT FOR WILD DUCKS

Browntop millet (*Panicum ramosum*) for duck food is adapted to many of the old rice fields of the southeast. With proper care, browntop can be grown and managed so there is little danger of producing the low pH condition in the soil. For duck food, browntop millet is planted in the middle of July. The soil can be kept wet until shortly before planting time, then drained enough for disking, planting and growing (60 days) and flooded again. (However, browntop does not have the salt tolerance of rice—1,000 ppm of salinity is maximum, whereas rice can be grown with five times this much.)

Japanese millet (*Echinochloa chusgalli* var. *frumentacea*) can be planted in a similar manner. Although it has a chafier seed than browntop and deteriorates faster when flooded, it will grow on wetter soils than browntop. Coast cockspur (*Echinocloa walteri*), a closely related species, will tolerate salinities of 5,000 ppm.

There are other duck foods which do not require prolonged drying of the land and therefore can be grown on cat clay soils. Most species of smartweeds are adapted. Some species of smartweeds as *Polygonum opelousanum* and *P. pennsylvanicum* will grow at salinities of 3,000 ppm.

Corn is a popular duck food but it cannot be grown on cat clay soils. Corn requires deep drainage, a water table at least 20 inches below the surface. A good example of the sequence of corn on cat clay soils is found in one of the fields on the Bear Island Refuge of the South Carolina Wildlife Resources Department. The first year there was a good crop. The second year, half of that yield. The third year, failure.

One of the best uses for the typical brackish water marshes is widgeongrass ponds for waterfowl. These are constructed by diking off areas which can be flooded continuously with at least 24 inches of brackish water from the tide or with a pump. There is no need to be concerned with the dense stands of needlerush (*Juncus roemerianus*) or cordgrass (*Spartina alterniflora*) normally found in these areas. With constant flooding 24 inches or deeper, both species will soon die and disappear.

Widgeongrass (*Ruppia maritima*) is the duck food to grow in these brackish ponds. It is a choice food of many kinds of ducks. Although it tolerates a wider range of salinity, widigeongrass grows best in water with about 10,000 ppm salt (one-third sea strength). This amount of salinity, with water depth of two feet or more, will also keep out pest plants such as tropical cattail (*Typha domingensis*), which has a fair degree of salt tolerance, particularly in shallow water. Where there is tidal variation, approximately the correct salinity for widgeongrass ponds can be maintained automatically with a flashboard riser water-control structure.

SALINE PONDS FOR FISH

A promising use of the more saline brackish marshes is impoundments to grow commercial crops of shrimp, oysters and mullet. These are best suited where water salinities are 18,000 ppm or more. The design is somewhat similar to widgeongrass ponds. Considerable research on the stocking and management of this kind of pond has been done by G. Robert Lunz, Jr., director of Bear's Bluff Laboratories, Wadmalaw Island, South Carolina.

Although a little aside from the point, investigations in Florida have shown that diking and flooding of brackish marshes is the most effective method of control of salt marsh mosquitoes (Philen and Carmichael, 1956).

CHEMICAL REACTIONS

The SCS Soil Survey Laboratory at Beltsville, Maryland has made detailed investigations into the chemistry of cat clays and has provided much of the technical information on these soils in this paper. For those interested in the chemical reactions which take place upon the draining and drying of cat clays, the following (from unpublished data of the Soil Survey Laboratory) are typical. You will notice that each reaction, whether it happens consecutively or concurrently, produces more sulfuric acid.

$$2FeS_2 + 70_2 + 2H_20 \rightarrow 2FeSO_4 + 2H_2SO_4$$

$$4FeSO_4 + 3H_2SO_4 + O_2 \rightarrow 2Fe_2(SO_4)_3 + H_2SO_4 + 2H_2O$$

$$Fe_2(SO_4)_3 + 4H_20 \rightarrow Fe(SO_4)_2 + H_2SO_4 + 2H_20$$

Microbiological oxidation plays an important role in increasing acidity when the soil is dried. Some micro-organisms use sulfur, hydrogen sulfide, and thiosulfates in their metabolism, producing sulfuric acid as a waste product. They will thrive in a pH range as low as three to four. Oddly enough, the Laboratory findings indicate that a slight application of lime may actually result in a more acid condition of cat clays by temporarily making conditions more favorable for the growth of these acid-forming micro-organisms.

The yellow material which characteristically forms in cat clays upon drying, was identified by X-ray diffraction at the Beltsville laboratory as jarosite, $KFe_3\ (OH)_6\ (SO_4)_2$ and coquimbite, $Fe_2(SO_4)_3 \cdot 9H_20$.

SUMMARY

A generally unrecognized condition exists in many coastal marshes which places limitations upon their development, either for wildlife, pasture, or cropland. It is the presence of polysulfides in the soil. These soils are referred to as "cat clays." When such soils are drained and dried, the sulfides oxidize to sulfates and sulfuric acid. The resulting pH of the soil becomes too low to grow any useful plants. This acid condition will persist for an undetermined period of years—now thought to be in terms of decades. Such enormous amounts of lime would be required to correct this condition as to be beyond feasibility.

Under fresh-water conditions, agricultural development and use of soils which contain polysulfides appear limited to a rice-type of culture. The same limitation applies to duck foods which simulate this type of culture by not requiring deep drainage or prolonged drying of the field.

Development of brackish areas with cat clay soils appear limited to range grazing, impoundments to grow widgeongrass for duck food, or impoundments to grow commercial crops of shrimp, oysters or fish.

When either fresh or brackish water is impounded on previously drained and dried areas of cat clays, the pH of the water rapidly drops to 2.0-3.0. It is then toxic to most forms of aquatic life. Field studies are underway to determine if repeated changes of water will exhaust the acid-forming material.

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DISCUSSION

MR. A. E. BORELL [Soil Conservation Service, Denver, Colorado]: I have a question regarding the identification of a cat clay. You mentioned that they are difficult to identify. Can the soil men make positive identification prior to drainage?

MR. NEELY: Well, actually, they can be identified by taking a sample of the soil, measuring its pH, and then air drying it for two or three weeks or a month and measuring its pH again. If there has been any drop in pH, you can almost be certain you have a cat clay soil, or one that has a high sulfide content.

The soil scientists are all working now to develop better techniques for identifying these cat clays. In the laboratory, the content of free sulphur can also be used for identification.

DISCUSSION LEADER FAHY: Mr. Neely, is there any method by which you can estimate the percentage of the coastal plain that is occupied by this particular type of soil?

MR. NEELY: The recognition of cat clays in the United States is relatively new and as yet we don't have detailed measurements of these cat clay soils. We think it is an enormous acreage, because almost all of the brackish and marsh areas that do not contain calcareous materials are probably cat clays.

Incidentally, since this paper has been prepared, cat clays have been identified in Puget Sound and New York State, so it is almost certain they extend over much of North America's coastal areas.

MR. ROBERT C. HILFIBRAN [State Natural History Survey, Urbana, Illinois]: I would like to ask about the original pH of the brackish waters used to rehabilitate the soil.

MR. NEELY: They usually run 6.5 to 7.

MR. HILFIBRAN: In other words, there is a fairly good dilution factor involved in removing the acid contents of the soil?

MR. NEELY: Yes, I am sure of that.

AN EPIZOOTIC IN GULF OF SAINT LAWRENCE FISHES

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Accounts of mass mortalities of marine fishes are not uncommon in scientific literature and the popular press, but few of these catastrophes have been definitely associated with a specific pathogen. An outstanding exception is found in sea herring (*Clupea harengus*) of the western North Atlantic, which have been known for almost half a century to be subject to periodic epizootics of a systemic fungus disease caused by *Ichthyosporidium hoferi*. The most recent outbreak occurred in the late spring and summer of 1954 and 1955 and to a lesser extent in 1956. During this period large numbers of herring died in the Gulf of Saint Lawrence from effects of the disease. During the same period, less extensive mortalities of alewives (*Pomolobus pseudoharengus*) and mackerel (*Scomber scombrus*) were reported from the same locality. The area encompassed by the herring mortalities was so extensive, and the numbers of fish involved were so great that studies were made by biologists of the Fisheries Research Board of Canada, the Department of Fisheries of the Province of Quebec, and the United States Fish and Wildlife Service. Several papers and reports have already appeared on aspects of this outbreak and resulting mortalities (Leim 1955, 1956; Sindermann 1956, 1957; and Templeman 1954). It is the purpose of this report to continue the documentation of this period, insofar as herring and certain other commercially important species are concerned. Effects on the fishery of the region seem quite marked, and rather clearly related to the disease outbreak. Although a complete analysis of the total ecological effect of the fungus epizootic must await several further years of observation and greater perspective, a summary of descriptive and experimental data obtained during the outbreak period seems warranted now.

MORTALITIES OF SEA HERRING DURING THE PERIOD 1954-1956

Widespread herring mortalities, particularly of mature spring-spawning fish, were first reported from the Gulf of Saint Lawrence in late spring and early summer of 1954 (Tibbo, unpublished data[1]). Dead fish were observed floating in shoals at the surface, were washed up on the shores of the Gulf, and were taken in nets of otter trawlers. Mortalities extended from the west coast of Newfoundland to the

[1]Typewritten report by S. N. Tibbo dated August 16, 1954, to the director of the Biological Station, St. Andrews, N. B. A copy of this report was made available to the author by Mr. Tibbo.

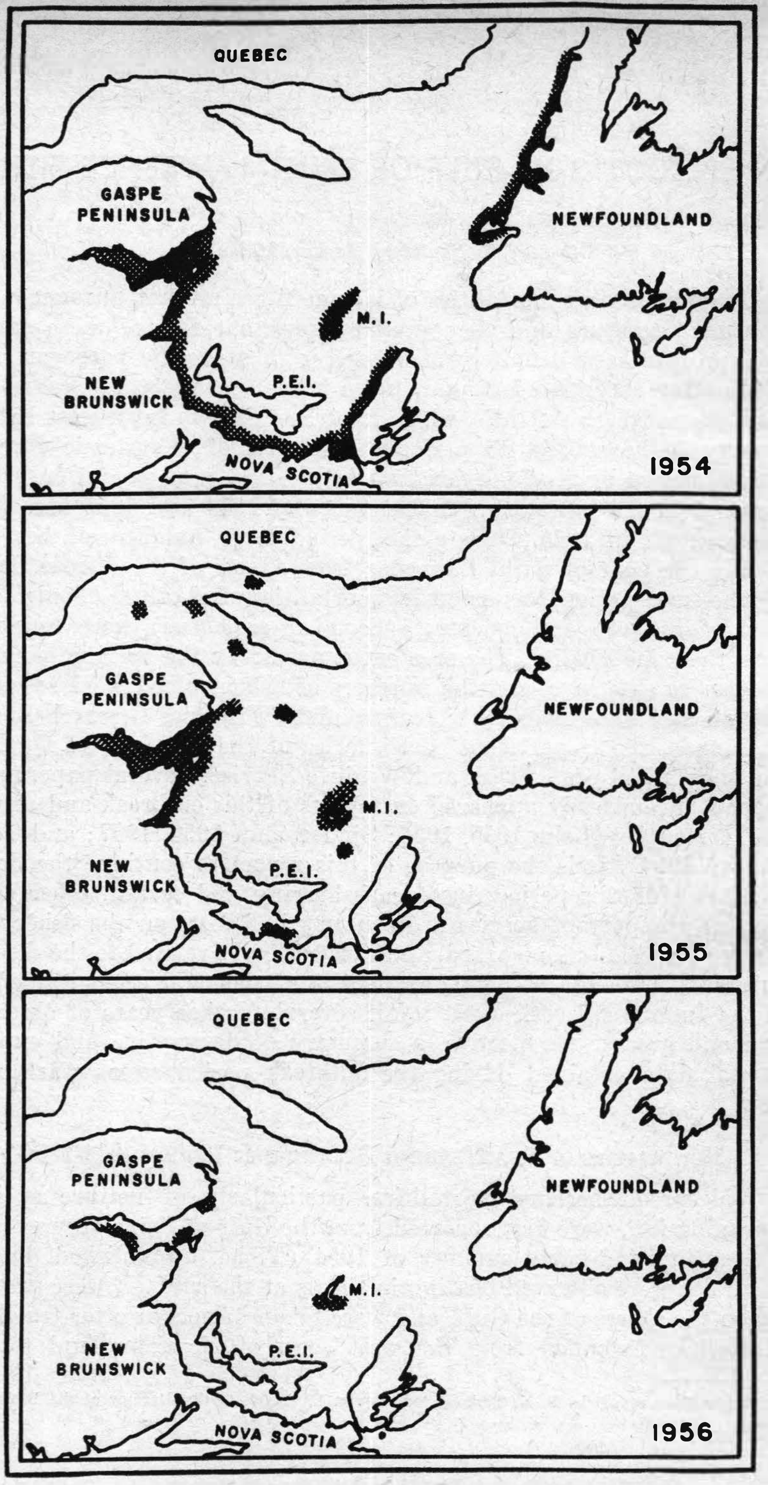

Figure 1. Locations of observed or reported mortalities of sea herring.

Gaspe coast, and from Anticosti Island to Northumberland Strait. Deaths were first apparent in mid-May, reached a peak in June, continued at a reduced rate through July, and apparently ceased in August. Abnormal, lethargic, moribund herring could be seen inshore, particularly near breakwaters, throughout the period. Deaths occurred sporadically in such inshore aggregations, the dying fish sinking to the bottom to become part of an extensive litter of herring carcasses. This pattern was repeated in 1955 as far as numbers of fish, abnormal behavior, and time were concerned. Mortalities in 1956 were drastically lower, being confined to the Chaleur Bay region and the Magdalen Islands, and to relatively few fish as compared to 1954 and 1955. No dead herring were found in 1957. Areas in which mortalities were observed and reported in each of the three years are indicated in Figure 1.

Wherever examined, dead fish were found to be infected with the fungus *Ichthyosporidum hoferi.* This pathogen causes systemic infection, with foci in the heart (Figure 2) and lateral line musculature. The disease affects fish of all ages and is probably acquired in in-

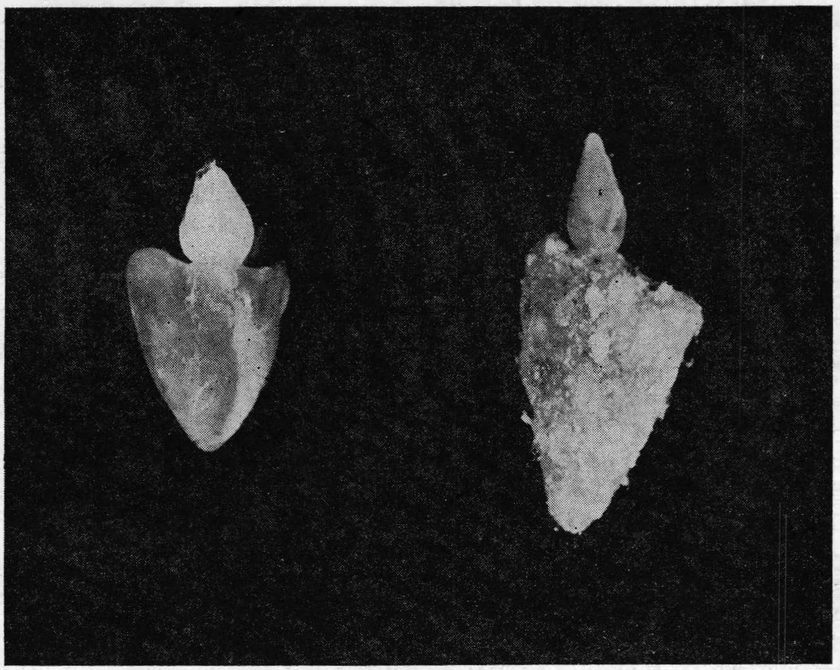

Figure 2. Hearts of normal (left) and fungus infected herring. Photograph by Mr. Paul Montreuil, Director, Marine Biological Laboratory, Grindstone, Magdalen Islands.

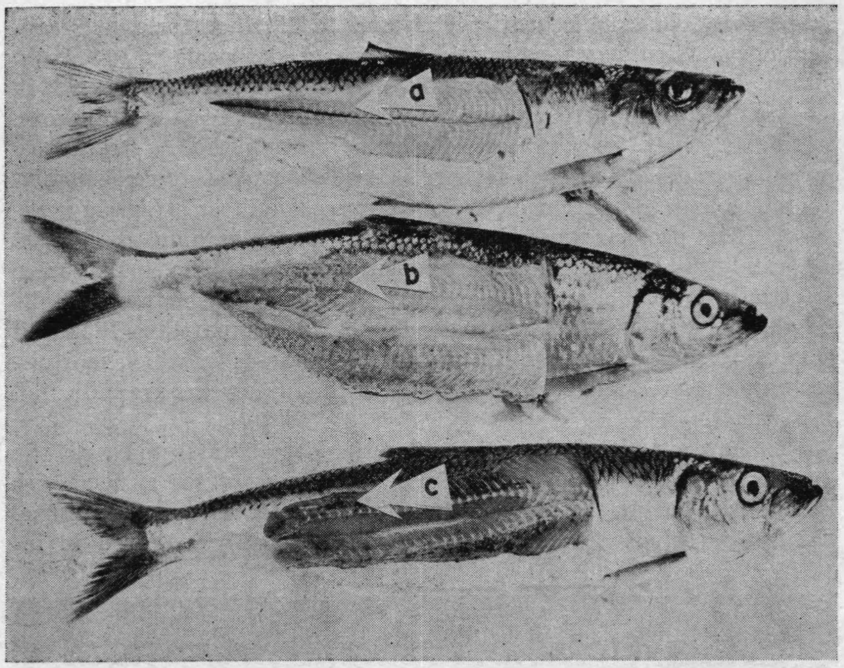

Figure 3. Lateral line musculature of mature herring. (a) uninfected, (b) acute infection with necrosis, and (c) chronic infection with pigmentation. Photograph by Mr. Paul Montreuil, Director, Marine Biological Laboratory, Magdalen Island.

shore areas. The causative organism has been experimentally transmitted directly from fish to fish (Sindermann and Scattergood 1954). Death of diseased fish seems due to circulatory failure in most cases, although massive involvement of organs other than the heart may be contributory. From examination of the course of the disease in 1955 and 1956, and from experimental work conducted during that period, it appears that the initial and extensive mortalities were caused by an acute phase of the disease, characterized by rapid massive fungus invasion of susceptible fish. Experimentally, this type of infection was terminal within one month from time of exposure. Acute infections, in addition to killing many fish, caused degeneration and necrosis of the body muscles, particularly the lateral line musculature (Figure 3b). Such diseased fish were poor for smoking, because they fell from smoke-house racks, and were not suitable for pickling, since they were already partly decomposed. Later sporadic deaths and infections apparent on gross examination were due principally to a subacute or chronic phase, characterized by marked host cellular response, in fish apparently more resistant to the disease organism. Abundant infections, principally of this type, were characteristic of late summer and autumn, after mass mortalities had apparently ceased. These infections were often accompanied by pigment deposition around fungus spores in the body muscles (Figure 3c), creating an additional problem for herring picklers.

Sampling in 1955 and 1956 disclosed a low disease incidence in the earliest (late April) run of herring, indicating that few heavily infected fish survived from the previous year. Coincident with first reports of mortalities, a rapid rise in incidence, especially of acute infections, occurred in late May, one month after the herring appeared inshore.

From observations made in 1955 it was estimated conservatively that at least one-fourth of the mature herring of the western Gulf were affected in that year (Sindermann 1956); this was later supported by the fact that herring landings for the entire Gulf in 1956 decreased one-third from the 1955 landings. There was no evidence that fishing effort had decreased during 1956. Mortalities in some Gulf areas in 1954 were at least as severe as in 1955, suggesting significant population decimation as a result of this outbreak; this was supported by the fact that Chaleur Bay landings, compared to the average for the

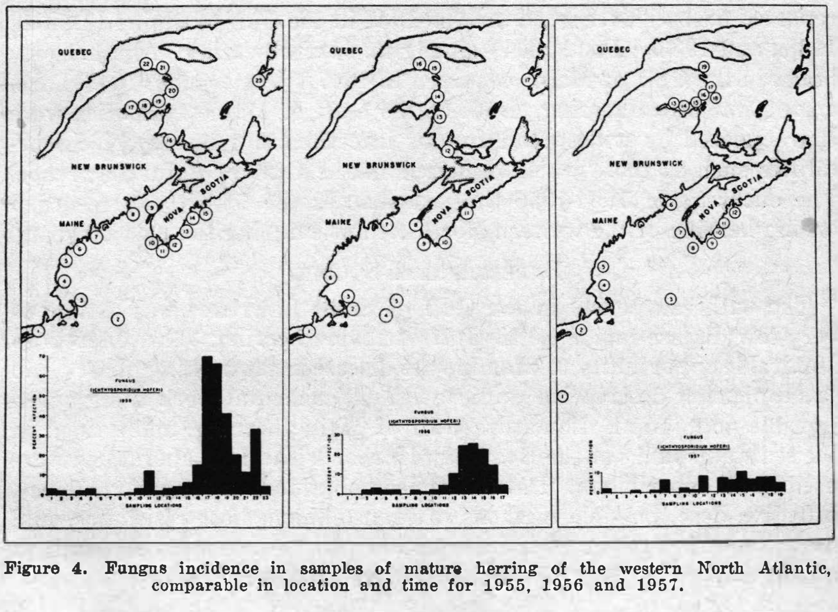

Figure 4. Fungus incidence in samples of mature herring of the western North Atlantic, comparable in location and time for 1955, 1956 and 1957.

previous ten years, were in 1955 only 74 per cent, and in 1956 only 62 per cent, and were lower than any other single year in the previous ten. Indications at present are that the 1957 catch was even lower.

Since mortalities in 1956 were greatly reduced, that year may be considered the first post-epizootic year. Disease incidence in the Gulf, except at the Magdalen Islands, was lower in 1956 than in 1955, and was much lower in 1957 than in 1956. Incidence averaged 27 per cent in 1955, 22 per cent in 1956 and 10 per cent in 1957. Fungus incidences in herring sampled in these years are graphed in Figure 4. Although not included in the graphs, it should be noted that early autumn incidences in the Gulf of Saint Lawrence were as high or higher than spring-early summer figures. For example, two September samples from Chaleur Bay in 1957 had incidences of 24 and 30 per cent, much higher than the spring-early summer average of 6 per cent. Also, one sample of trawled herring from the Magdalen Islands in 1957 had an incidence of 78 per cent, possibly representing a differential deeper-water aggregation of infected fish.

This fungus disease is enzootic in western North Atlantic herring stocks, and is characterized by periodic outbreaks in the Gulf of Maine and the Gulf of Saint Lawrence. It was first reported from Gulf of Saint Lawrence herring by Cox (1916) after an epizootic and mortalities in 1913-1914. According to that investigator, a similar outbreak had occurred in the Gulf of Saint Lawrence in 1898. The next reported outbreak occurred in 1930-1931 in the Gulf of Maine (Daniel, 1933a and 1933b; Fish, 1934) among immature herring. Another outbreak in the Gulf of Maine occurred in 1947 (Scattergood, 1948), also among immature herring. Both of the Gulf of Maine epizootics were characterized by widespread fungus infections but no reported mortalities such as those which occurred in the Gulf of Saint Lawrence. The outbreak of 1954-1956 thus constitutes the fifth to be recorded among herring of the western North Atlantic during the past 60 years.

EXPERIMENTAL STUDIES

The outbreak period in the Gulf of Saint Lawrence was a time of very low disease incidence in Gulf of Maine herring. This offered an admirable opportunity to examine the disease in contrasting phases, and to supplement descriptive studies with experimental work using a susceptible population. Immature Gulf of Maine herring, maintained in the sea water tanks of the Boothbay Harbor Fisheries Laboratory, were used in all experiments. Data have been obtained on fungus virulence, infective dose, possible methods of transmission, host resistance, and duration of infection. This information will be presented in detail in a later paper, but may be summarized as follows:

(1) The disease can be transmitted by feeding spores removed from infected fish. Exposure of 50 age-group-1 herring to 2 x 10^5 spores in a single dose resulted in no infection, but the same dose given on two successive days to another experimental group of 50 fish resulted in infections in four (eight per cent).

(2) Experimental groups of 50 age-group-1 herring fed increasing numbers of fungus spores (above the dosage in (1) above) exhibited increasing incidence of infections of the subacute or chronic type up to a certain level of dosage (usually 4 exposures to 2 x 10^5 spores on 4 successive days); above this, acute infections and mortalities also occurred.

(3) Acute infections occurred in experimental fish within one month from time of exposure to a sufficiently large number of spores. These infections were characterized by massive invasion of the heart and necrosis of tissue adjacent to spores, with little host cellular response. Subacute or chronic infections, characterized by pronounced host cellular response, occurred after one month from time of exposure. Such infections were progressive and terminal in most experimental fish, while in a few they persisted for 18 months.

(4) An experimental epizootic, produced in 2000 age-group-0 herring by exposure on four successive days to doses of 2 x 10^5 spores each, resulted in infection of 23 per cent of the population—8 per cent acute and 15 per cent subacute. The disease was terminal in all but light chronic cases within three months. Mortalities from acute infections occurred from 14 to 30 days, and from heavy chronic infections after that time. Control fish were entirely negative for the disease throughout the experiment.

(5) From percentage of infections obtained, age-group-0 herring appeared to be more susceptible to identical dosages of spores than age-group-1 or age-group-2 fish.

(6) The fungus organism from Gulf of Saint Lawrence herring was similar to that from Gulf of Maine herring in its effects on experimental fish. Fungus organisms from the two Gulfs did not differ in culture morphology or growth rate.

When experimental results are related to observations of the outbreak in nature and to previous studies, a somewhat coherent picture of the disease in epizootic form begins to emerge, although there are still large gaps in our knowledge. It does appear that infection pressure and host susceptibility play major roles here, as they have been found to do in other epizootics and epidemics.

ECOLOGICAL IMPLICATIONS OF THE DISEASE OUTBREAK

The Gulf of Saint Lawrence herring population has been decimated by this disease outbreak, although effects may be transient. Combining experimental findings with field observations of the extent of mortalities, with disease incidence disclosed by sampling, and with catch statistics, it may be estimated conservatively that at least half the mature herring of the Gulf were destroyed during the outbreak period 1954-1956. According to Cox (1916) the herring catch in the Gulf was reduced for several years following the 1913-1914 mortalities. Outbreaks of the same disease in Gulf of Maine herring in 1930-1931 and in 1947 were not accompanied by observed mortalities, and the fishery did not seem to be immediately affected. However, this fishery concentrates on herring of the 0 and 1 age groups, which were heavily infected, and it is interesting and perhaps significant that in 1950-1951, when these fish would have contributed to the spawning stocks, there appeared to be a pronounced reduction of the inshore mature herring population of the Gulf of Maine. It should be noted, however, that little is known of offshore spawning populations, so that this apparent reduction might be due to a shifting of spawning grounds. While other interpretations are possible, these limited data, plus observations of the magnitude of the mortalities in 1954 and 1955, tend to support the hypothesis that the fungus disease is an important factor in shaping fluctuations in abundance of herring of the western North Atlantic. Mature as well as immature fish are affected; a significant part of the population is involved during outbreaks; and many of the fish that become infected are killed.

The fungus disease has had both direct and indirect effects on species other than herring in the Gulf of Saint Lawrence. Alewives (gaspereau) and mackerel are known to be susceptible to this fungus organism (Sproston, 1941; Sindermann and Scattergood, 1954). Scattered mortalities of both these species were reported and observed in the Gulf in 1954 and 1955.

The presence of great quantities of dead and dying herring might be expected to affect bottom-feeding animals and scavengers. Examination of the cod and lobster landing statistics for the Gulf of Saint Lawrence, and for Chaleur Bay in particular, gives some indication that this may have been the case. In both 1954 and 1955, the years of heaviest mortalities of herring, lobster catches declined sharply coincident with reports of mortalities—probably because lobsters were feeding on dead herring, and had little reason to enter traps for food. Cox, reporting on the 1913-1914 mortalities, also noted that the lobster catch, which was above average up to the time the herring began dying, suddenly fell off, and even crabs failed to enter traps.

Cod taken in 1954 and 1955 were frequently found to have herring remains and also the fungus organism in their digestive tracts, suggesting that they were feeding heavily on herring. This was further suggested by the fact that when the herring mortalities began in 1954, the catches of the Gaspe long-line and hand-line cod fisheries deceased sharply, while those of the otter trawl fishery remained unchanged (Ronald, in press). This also agrees generally with the observation of Cox that during the 1913-1914 outbreak cod were found closer inshore than usual, refused bait, but were caught freely in salmon nets, an unusual occurrence. Cod landings in Chaleur Bay, which seemed to be a focus of the disease outbreak in the herring, were in 1956 (the first post-epizootic year) 52 per cent above the average for the preceding eight years, and higher than any single year during this period.[1] Present indications are that the 1957 catch was also exceptionally high. According to Martin (1957), landings of cod in the provinces of Quebec, New Brunswick, and Prince Edward Island in 1956 were the largest on record. Increased landings were due to larger size and not to greater numbers of fish. Individual cod were considerably larger and the growth rate was much higher in 1955-1956 than in the period 1947-1952. Although other factors might be involved, the increase may well be related to the abundance of diseased and dying herring in 1954 and 1955. The relationship of this greater growth of Gulf of Saint Lawrence cod to increased availability of herring was suggested by Martin (1956) and is supported by observations made during the present study and also by Ronald (in press). If such a relationship is real, the outbreak period has positive as well as negative aspects.

The new observations and experimental findings reported here, together with other reports referred to, suggest that this outbreak period was one of great ecological change in the Gulf of Saint Lawrence. Effects may be only temporary, but the important role of epizootic disease in the marine environment has been well illustrated.

SUMMARY

Extensive mortalities of sea herring and lesser mortalities of alewives and mackerel occurred over much of the Gulf of Saint Lawrence in 1954 and 1955, and smaller mortalities in 1956. Wherever examined, such mortalities were found to be associated with systemic infection by the fungus *Ichthyosporidium hoferi,* a pathogen responsible for a similar outbreak in the Gulf of Saint Lawerence in 1913-1914, and with

[1]Comparable cod landing statistics for Chaleur Bay are available only since 1947.

outbreaks in the Gulf of Maine in 1930-1931 and in 1947. Dead herring could be found in 1954 and 1955 floating at the surface, dead on the bottom, and washed up on the shores of the Gulf. The nets of otter trawlers were frequently fouled with dead and decomposing herring from the bottom. Disoriented, lethargic, infected herring could be seen dying in inshore areas during the early summer, after the time when normal fish would have moved offshore following spawning. From sampling done in 1955 it was estimated that one-fourth of the mature spring-spawning herring of the western Gulf were affected during that year alone, with indications of a similar incidence in 1954.

Experimental studies have demonstrated that, depending on host susceptibility and infective dose, the disease may occur in either acute or chronic phases, rapidly terminal in the former and progressively so in the latter. This, combined with field observations of magnitude of mortalities, with disease incidence disclosed by sampling, and with catch statistics, suggests significant herring population reduction as a result of the outbreak.

Changes in the fisheries for other commercially important species of the Gulf of Saint Lawrence, notably cod and lobster, have been related to the epizootic in herring.

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DISCUSSION

MR. RAY LANE [Urbana, Illinois]: I did not notice any checking here on post-contamination possibly from soil erosion or perhaps sewage disposal. Has that been ruled out?

DR. SINDERMANN: Not entirely. This is one of the things that was brought up in the Gulf, where there are all kinds of pulp processing plants and so on. Probably the fact that we can reproduce this disease in many of its aspects in our experimental tanks in a completely different environment tends at least to reduce the possibility of this type of effect.

We have investigated the possible role of temperature in these epizootics as far as possible and have found no clear-cut relationship. We are, of course, able to culture this organism and the culture characteristics and effects of culture material seem to be identical to those in the St. Lawrence during the epizootic.

DISCUSSION LEADER FAHY: Dr. Sindermann, on those arrested cases where the fish, presumably your experimental fish, persisted for 18 months, did you notice what might be the expected effect on reproductive organs?

DR. SINDERMANN: In the Gulf of Maine we deal almost exclusively with immature herring and used them in the experimental work. We have little chance of obtaining mature fish, so the effect on reproductive abilities could not be determined. However, we have noticed from sampling in the St. Lawrence, that chronic infections, even heavy ones, do not seem to prevent reproduction. We found heavily infected, chronic type infections, and the fish still seemed to be either ripening or in the process of laying eggs.

MR. WILLIAM H. MASSMAN [Virginia Fisheries Laboratory, Gloucester Point, Virginia]: What other fishes are infected by this fungus?

DR. SINDERMANN: The disease organism shows a remarkable lack of fastidiousness in host selection, since, in addition to herring, flounders, alewives and mackerel are known to be susceptible. We have experimentally infected killifish and goldfish. European workers know the organism primarily as a pathogen of aquarium and fresh-water fishes—principally salmonids. Fish and Wildlife Service pathologists in the western United States have recently recognized and experimented with a fungus pathogen of trout and salmon that bears a strong resemblance to our beast. The organism has been reported from several genera of calanoid copepods, and we have experimentally infected *Calanus finmarchicus*. We have not, however, found natural infections in plankton collections from the outbreak area. In the Gulf of Maine, infections in alewives seem to parallel those of herring, although incidences in the former are lower. The histological picture of infection in alewives is one of greater host response to the presence of fungus, and external and gross symptoms are also less pronounced than in herring. Herring do seem to be the primary hosts for this parasite in the western North Atlantic, although other species may act as reservoirs.

MR. ROBERT C. HILFIBRAN [State Natural History Survey, Urbana, Illinois]: Do you have any information on the amount or increase of spores during the siege of infectivity and also where did you get the spores that you used in setting up your synthetic infections?

DR. SINDERMANN: We have been able to find spores in bottom sediments in the Gulf of St. Lawrence. We did not get up there early enough to see what the spore condition was before the outbreak. We have been able to keep the spores in sterile sea water at sea water temperatures and they survive from autumn to the following spring with no apparent reduction in viability, at least in terms of cultured germination.

The spores in the herring are infective to other herring. Usually in these experimental exposures, we remove the spores directly from the fish, and they are infective to other fish, although culture material has been tried. The culture growth is so slow and so sparse that it would take extensive preparation to get sufficient spore material. We use large numbers of spores to obtain these infections. Apparently the resistance is high or the infectivity of spores is low. So we need massive doses to obtain experimental infections.

DISTRIBUTION AND ABUNDANCE OF GRAY WEAKFISH IN THE YORK RIVER SYSTEM, VIRGINIA[1]

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For the past two years, monthly surveys have been made with an otter trawl in Virginia waters of Chesapeake Bay and its estuaries, at a series of sampling stations extending from the mouth of the Bay to fresh water 80 miles up the York River estuary. These surveys are part of a larger scheme to study life histories and fluctuations in abundance of migratory fishes and certain invertebrates in tidal waters of the state. One purpose has been to investigate the merits of a systematic trawling program as a method of estimating size and age composition and relative abundance of species caught by the commercial and sport fisheries, on the hypothesis that this may be more efficient and accurate than a program of sampling commercial catches.

One of the most important commercial and sport fishes caught in considerable numbers in the trawl has been the gray weakfish, sea trout, or squeteague (*Cynoscion regalis*). This report summarizes observations on seasonal and local variations in availability and length of this species taken in trawl catches in 1956 and 1957.

Weakfish are believed to spawn outside the mouth of Chesapeake Bay during May, June and July (Pearson, 1941). Larval weakfish have been taken in plankton nets within the mouth of the Bay by Pearson (*op. cit.*), who stated that the young became semi-demersal at a length of about 10 mm. and that their favorite habitat was brackish coves and creeks. Welsh and Breder (1923) believed that during their first summer young weakfish remain in or near waters in which they were hatched. Hildebrand and Cable (1934) suggested that in estuaries young weakfish prefer soft or muddy bottoms in certain areas. Hildebrand and Schroeder (1927) found few young weakfish in Chesapeake Bay in summer.

METHODS

Sixteen sampling stations, separated by intervals of approximately five nautical miles, were established in lower Chesapeake Bay and the York and Pamunkey Rivers (Figure 1). With two exceptions (June 1956 and April 1957) stations were sampled each month from April 1956 to May 1957). Sampling usually was done about the same time each month and took four days, four stations each day. Station locations and mean water depths are listed in Table 1.

[1]Contributions from the Virginia Fisheries Laboratory. No. 81.

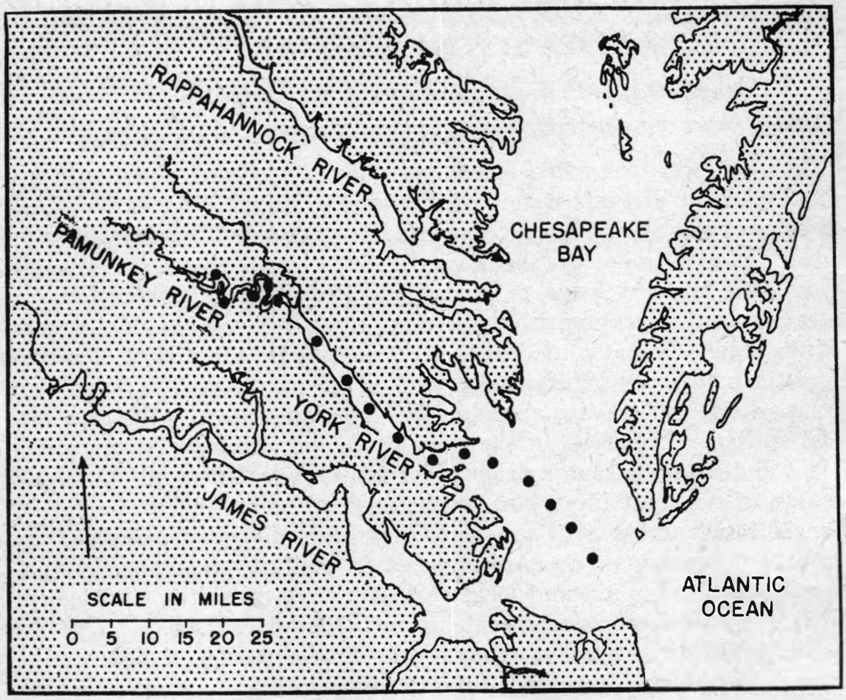

Figure 1. Lower Chesapeake Bay, York River and Pamunkey Rivers showing stations sampled by trawl each month from April to May 1957. Stations are numbered consecutively from 1 at the mouth of the Bay to 16 in the Pamunkey River.

Sampling was done with a 30-foot semi-balloon shrimp trawl having one-inch mesh (stretched measure) in the wings and body and three-quarter inch mesh in the cod end. The net was dragged in the same direction as the tidal current for 15 minutes at a speed of approximately 3 knots. In the Pamunkey River, after January 1957, snags and large quantities of organic debris interfered with trawling and tows were shortened to 7½ minutes. Because previous trials had shown that catches in duplicate and triplicate hauls did not vary more than expected by chance, only one haul was made at each station. All fishes, crabs, and shrimps were sorted and subsamples were removed for length measurements and scale samples.

Estimates of relative abundance of weakfish were based on pooled catches at groups of four adjacent stations. The lower Bay was represented by stations 1 to 4, lower York by stations 5 to 8, upper York by stations 9 to 12, and Pamunkey River by stations 13 to 16.

Surface and bottom water temperatures and salinity samples were

TABLE 1. STATION NUMBERS, LOCATIONS, MEAN DEPTHS, AND MAXIMUM, MEAN AND MINIMUM SALINITIES IN LOWER CHESAPEAKE BAY AND YORK AND PAMUNKEY RIVERS IN 1956 AND 1957

	Station Number	Location N. lat.	Location W. long.	Depth ft.	Salinity o/oo Maximum	Salinity o/oo Mean	Salinity o/oo Minimum
Chesapeake	1	37° 01′	76° 03′	50	30.7	28.1	24.4
Bay	2	04′	06′	45	30.1	27.0	22.1
	3	08′	11′	40	30.1	25.3	17.6
	4	10′	15′	35	28.8	24.5	21.8
Lower	5	13′	18′	35	26.5	23.8	20.7
York	6	15′	22′	60	27.3	24.8	20.2
River	7	14′	27′	50	27.2	23.7	17.0
	8	19′	36′	30	23.1	21.5	16.5
Upper	9	23′	39′	35	21.7	19.3	13.0
York	10	26′	42′	25	20.5	16.6	11.5
River	11	28′	44′	30	18.5	14.1	9.7
	12	32′	50′	25	12.0	6.7	1.7
Pamunkey	13	34′	51′	30	7.0	2.2	0.1
River	14	33′	53′	30	3.1	0.7	0.1
	15	32′	58′	25	1.0	0.3	0.1
	16	35′	59′	25	0.8	0.4	0.1

obtained at each station. Salinity was determined by titration with silver nitrate and corrected from Knudsen's Tables (1901). Salinities at which weakfish were caught (Table 1) ranged from 0.1 to 30.7 o/oo and temperatures averaged from 9.7 to 25.1° C. Mean bottom temperatures in ° C. for each cruise were: May 18.5, July 25.1, August 25.0, September 23.6, October 18.0, November 14.1, December 9.7, January 3.0, February 5.9, and March 8.7.

SEASONAL VARIATIONS IN AVAILABILITY

Day and night seining along the shores of Chesapeake Bay and the York River failed to produce great numbers of young weakfish, and shoal water dragging with an otter trawl was even less successful. It was concluded, therefore, that young were concentrated in deeper waters. Weakfish have also been captured near the surface at night by surface trawl (Raney and Massmann, 1953) but usually remain near the bottom.

The distributional pattern of young weakfish did not coincide with that of older fish, and there is no reason to believe that availability of the two groups was proportional to their true abundance in the sampling area. Therefore, the two groups have been considered separately. Yearlings appeared first in the catches in July (Table 2). They were small at this time, and the coarse meshes of the trawl retained few less than 50 mm. in length and lost some fish up to 80 mm. long. Therefore, though greatest availability to the trawl was not reached until September, the peak of abundance almost certainly was reached earlier. In fall, availability fell off rapidly as the fall migration developed, and by December few were left in the survey area. No weakfish were caught

TABLE 2. NUMBERS OF YOUNG WEAKFISH TRAWLED PER HOUR[1] IN CHESAPEAKE BAY AND THE YORK AND PAMUNKEY RIVERS FROM APRIL 1956 TO MAY 1957[2]

Month	Chesapeake Bay	Lower York River	Upper York River	Pamunkey River	Mean
July	0	1	83	0	21
August	44	160	148	241	148
September	70	865	218	203	339
October	451	122	13	20	152
November	350	17	0	0	92
December	19	0	0	0	5
Mean	85	97	39	42	

[1]Number of fish per hour is the sum of four 15-minute tows made at four stations in each area.

[2]Cruises made in April and May 1956, and January, February, March, and May, 1957, are not included because no weakfish were caught. Cruises were not made in June 1956 and April 1957. Pamunkey River stations were not sampled in January 1957 and Chesapeake Bay stations were not sampled in May 1957.

in winter, and it was presumed that all had moved out to deeper and warmer waters in the ocean.

Older weakfish first appeared in trawl catches in May (Table 3) and their availability remained remarkably constant through August. In September catches began to decline, and by October and November few were left. The earlier decline in availability as compared with yearlings may have been a consequence of growth, increasing the ability of older fish to escape the net, but it also is possible that older fish begin their oceanward migration earlier.

LOCAL VARIATIONS IN AVAILABILITY.

Yearling weakfish were first captured in the upper York River in July (Table 2). It is believed that newly-spawned weakfish moving into the Bay and rivers were too small to be retained in the trawl until they had reached the upper York. In August yearlings were trawled in the Bay and the river, but were most abundant in the Pamunkey. In September the center of abundance had shifted to the lower York, and in October to the lower Bay. At this time samples from the upper York and Pamunkey Rivers contained few yearlings, suggesting that most had moved downriver toward the Bay. Nearly all young caught in November were in the Bay and almost none at river stations. By December, oceanward migration apparently was well advanced, for few were caught in the Bay and none in the rivers.

Young croakers perform a similar but more leisurely migration up and down the York River, ascending to waters of low salinity in late summer and fall, and returning to Chesapeake Bay and the ocean the following summer and fall (Haven, 1957).

Weakfish more than one year old first appeared in May, concentrated in the York, especially the upper river (Table 3). In this respect their movements were similar to yearlings, which were first taken in numbers from the upper York. A gradual downriver movement appeared to take place during summer, and the region of maximum concentration shifted to the Bay in July and August. Availability in the Bay reached a peak in August, but by September many had apparently moved out to sea and few were present in the rivers. In October and November only a few stragglers were caught in the Bay and rivers. No weakfish were caught during the winter.

No weakfish more than one year old were caught at stations in the Pamunkey River, suggesting that older weakfish may not be as tolerant of fresh water. It is also interesting to observe that older weakfish apparently began to move out of the Bay about two months before the yearlings. This suggests that they may be less tolerant of cold waters.

SEASONAL VARIATION IN LENGTH

Fork lengths of weakfish from trawl samples obtained each month from May to November are presented in Figure 2. Two distinct size groups are evident, yearlings and a group of larger fish one year of age or older. Unpublished studies based on scale readings have shown that more than 80 per cent of weakfish larger than yearlings caught in our trawl were one year old and most of the remainder were two years old. These studies also showed that our net, apparently an efficient sampling gear for weakfish one year old and less, did not sample larger, older fish in the same proportions that they were caught in commercial fishing gears. Just as young fish are able to escape capture in pound nets, so older fish are able to escape the mouth of the trawl. Therefore, the various age groups are not necessarily captured in proportion to their true abundance. The length frequency polygons

TABLE 3. NUMBERS OF WEAKFISH ONE YEAR OLD AND OLDER TRAWLED PER HOUR[1] IN CHESAPEAKE BAY AND THE YORK AND PAMUNKEY RIVERS FROM APRIL 1956 TO MAY 1957[2]

Month	Chesapeake Bay	Lower York River	Upper York River	Pamunkey River	Mean
May	13	38	91	0	35
July	72	41	15	0	32
August	105	22	23	0	37
September	45	9	12	0	17
October	0	7	1	0	2
November	2	0	0	0	1
May	....	58	53	0	37
Mean	21	15	16	0	

[1]Number of fish per hour is the sum of four 15-minute tows made at four stations in each area.

[2]Cruises made in April and December 1956 and January through March 1957 not included because no weakfish were caught. Cruises were not made in June 1956 and April 1957. Pamunkey River stations were not sampled in January 1957 and Chesapeake Bay stations were not sampled in May 1957.

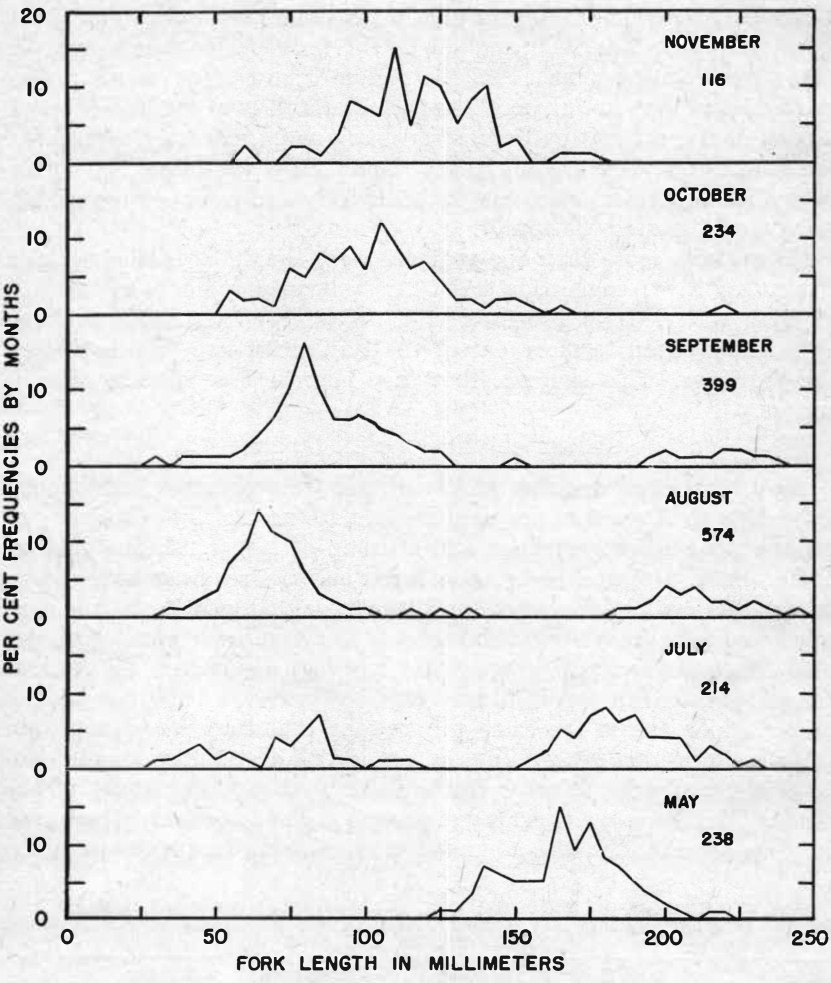

Figure 2. Length frequencies of gray weakfish caught by trawl each month in Chesapeake Bay and the York and Pamunkey Rivers in 1956. Total numbers of fish in each monthly sample are given.

presented in Figure 2 suggest that most of the weakfish larger than yearlings were one year old.

Yearling weakfish, first caught in July, included two distinct size groups with modal lengths of 45 and 85 mm., possibly from separate spawnings. The two groups were not evident in succeeding monthly samples, but the range in lengths of yearlings progressed from 65 mm. in August to 110 mm. in November.

The wide range of sizes in fish of a single year class makes it impossible, on the basis of length alone, to distinguish one year old fish when they return to the Bay in spring. In trawl samples, however, there are so few older fish that some idea of growth in the second year could be gained by following the modal length group, which shifted from 165 mm. in May to 220 mm. in October.

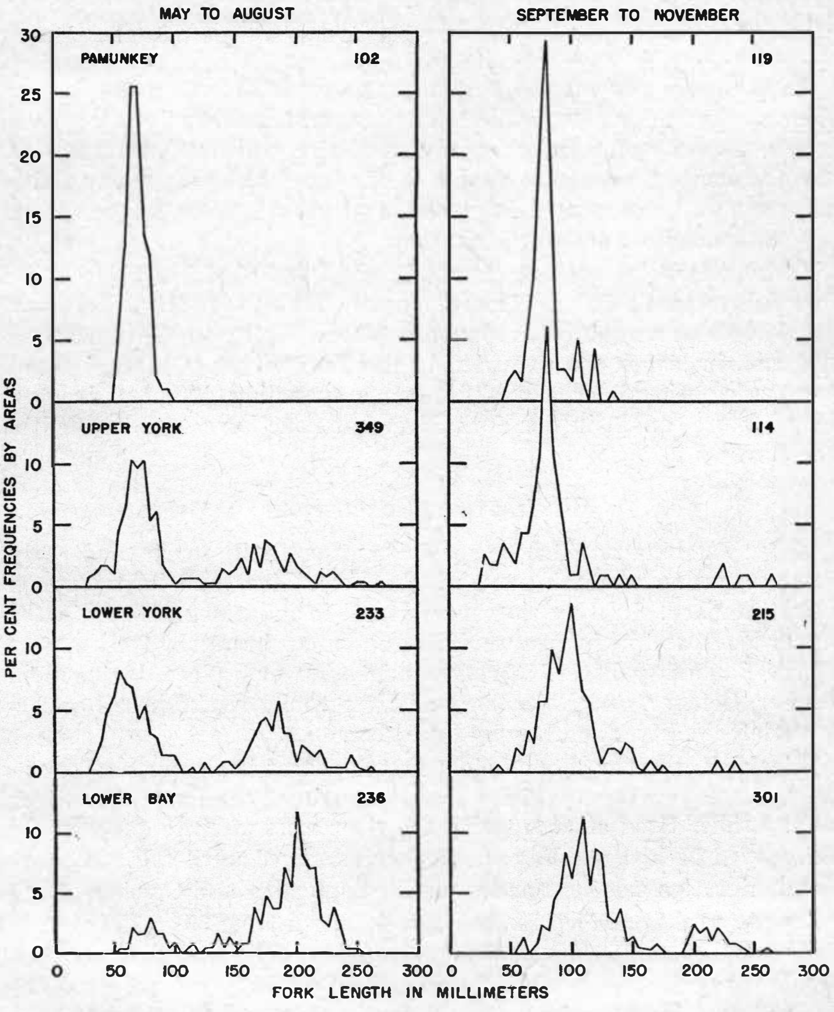

Figure 3. Length frequencies of gray weakfish caught by trawl in Chesapeake Bay, Lower and Upper York and Pamunkey Rivers during the periods May to August and September to November 1956. Total numbers of fish in each monthly sample are given.

LOCAL VARIATIONS IN LENGTH

Lengths of weakfish trawled early and late in the season in Chesapeake Bay, lower York, upper York and Pamunkey River are presented in Figure 3. Mean lengths, especially of yearlings, varied in different locations. From May to August the smallest fish of both ages were in the lower York, those in the upper York and Pamunkey being progressively larger. From September to November the opposite was true, the smallest fish being found in the Pamunkey while those in the York and Bay were larger.

In the early part of the season young weakfish were captured on their upriver migration, while later they were caught migrating back to sea. Because of their extremely small size, which allowed most of them to escape through the meshes of our trawl, the youngest weakfish were not well represented in catches and growth early in the season was not as distinct as growth later on.

Older weakfish were not caught in the Pamunkey but their mean length increased regularly from the upper York to the Bay. This may also have been a result of seasonal migration. Eight weakfish exceeding 250 mm. in length were trawled in the York River. On other trawl surveys occasional large weakfish, some exceeding 400 mm. in fork length, were caught in the York River but none have been trawled in the Bay.

SUMMARY AND CONCLUSIONS

After hatching on offshore spawning grounds in spring and early summer, young weakfish move up the York River and its tributary, the Pamunkey. In July they were found in greatest numbers in the upper York, and in August were most numerous in nearby fresh waters of the Pamunkey River. A return migration took place during September, October, and November and most young weakfish had apparently left the River and Bay by December.

Weakfish one year old and older first appeared in the upper York in May, but there was no evidence that they entered the Pamunkey River at any time. Soon after entering the river most of these one-year-old fish moved back to the Bay where they remained until fall. The seaward migration was most active during September and October.

Young weakfish which ranged in fork length from 30 to 120 mm. in July were 65 to 150 mm. long in November. The length range of a single year class was so large that fishes older than yearlings could not be separated into age classes on the basis of size alone. Modal lengths progressed from 65 mm. in August to 110 mm. in November. Older fish advanced from a modal length of 165 mm. in May to about 220 mm. in October.

Information on availability and size composition of weakfish in commercial catches are not presented here, but it is of interest to mention how they compared with trawl catches. As might be expected, poundnet catches contained relatively few yearling trout, and those that did appear in the commercial catch were sorted out as trash fish. Trawl catches, therefore, were much more useful for obtaining estimates of relative abundance of the incoming year class. If the relative availability of young fish to trawls is proportional to their availability in succeeding years in commercial and sport catches, then trawling surveys will be useful for predicting fishing success.

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DISCUSSION

MR. JACKSON DAVIS [University of Kansas, Lawrence, Kansas]: How do the food habits of the trout differ later from the time they are in the Bay?

MR. MASSMANN: We would certainly like to know. We hope that within a short time we will be in a position to obtain much better information on food than we now have. We have been taking samples to get some idea of the bottom organisms, because the smaller fish feed largely on bottom organisms and we expect, before long, to begin food-habits work on the fishes throughout the year and in different locations. But we don't have much information yet.

DISCUSSION LEADER FAHY: I would like to ask about the length range of 65 to 110 millimeters in yearlings. Do you consider this to be indicative of a long spawning season for the species?

MR. MASSMANN: Yes, I think it indicates a long spawning season and also that the growth in all of our fishes is quite extended. Length frequencies are difficult to use and I think that is also why we have had so much trouble reading scales, because of the long spawning season. Perhaps there are other factors, too.

PROBLEMS RELATIVE TO THE ATLANTIC COAST STRIPED BASS FISHERY AND STATUS OF ITS BIOLOGICAL RESEARCH

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The Atlantic Coast distribution of striped bass, *Roccus saxatilis* (Walbaum), ranges from the St. Lawrence River in Canada to the St. Johns River in Florida, and in the Gulf of Mexico from western Florida to Louisiana. In 1955, the year of most recent available catch data, 5,000,000 pounds of striped bass valued at over one million dollars were taken commercially. In its range south of North Carolina, both sport and commercial catches are relatively small as compared to those of the middle and north Atlantic States. Throughout the range, records of sport catches are virtually non-existent, but they are known to be large. The striped bass fishery ranks high economically with the fisheries of other commercially exploited species, and its status as a sport fishery is increasing each year.

Because of its importance to the two fishing interests, an examination is made in this report of the more outstanding problems which are now confronting the striped bass fishery, the progress in research which has been and is being made, and the manner in which future research should be designed toward establishing management criteria.

PROBLEMS IN NEED OF SOLUTION

The most comprehensive problem now facing biologists engaged in striped bass research is that of advancing to a point where legislative bodies may be guided wisely in arbitrating such issues as that now existing between sport and commercial groups in the capture of striped bass. The legislative leaders should be able to rely upon scientific fact placed at their disposal by fishery biologists regarding proper regulation of harvest by both sport and commercial fishermen and regarding other fishing and biological factors. Otherwise, legislation precedes research and subjects the fishery to unrealistic management.

One of the preliminary steps to be taken in providing data for use in management of this fishery is that of determining population magnitude and its relation to catches. Catches have increased erratically in recent years, but there is no assurance that population size has increased correspondingly. Even though complete catches were recorded for each year, they alone would not necessarily reflect population size because catch depends upon the amount of effort expended in the fishery as well as the size of the population. The true status of the fishery in relation to the sizes of existing stocks is virtually unknown, and it is entirely possible that overexploitation of a diminishing population is in effect but unrecognized. Conversely, it is possible that greater fishing pressure can be exerted without reducing population size to a critical level.

With the procurement of complete catch and effort records from sport and commercial fisheries throughout the striped bass range, thorough tagging and recovery programs are necessary for the determination of population sizes. Numerous tagging programs have been undertaken on this species, but the experimental design of the programs has been limited largely to the study of migrations and has failed to incorporate the type of data necessary for scientific evaluation of the populations. Acceptable exploitation rates cannot be prescribed until the relationship of catch to abundance is established.

Systematic sampling of catches and subsequent aging by the scale method are necessary in determining the composition and abundance of exploitable fish by age groups. The determination of sex ratios among age classes through sampling of catches also deserves attention if the fullest interpretation of population dynamics, fish movement, and spawning activity are to be made.

Striped bass are noted for being subject to occasional super increases in abundance such as those which were produced in the middle Atlantic area in 1934 and in 1940 and which appeared in the fisheries in 1936 and 1942. Presently little is known concerning the causative factors which influence such outstanding production and/or survival. Abnormal abundance becomes obvious when a group of fish reach the age of exploitation after which time the particular age class can be kept under observation during several fishing seasons for the analysis of the effects of fishing and natural mortality upon the stocks. However, a problem whose elements are more obscure and hence less simple is that of appraising the effect of a combination of biological influences upon actual spawning production and the development of ova, larvae, and immature fish. In short, we have seen that there have been years in which abundant year classes occurred in nature, the responsible factors for which have not yet been fully determined and which warrant investigation.

Another development which now faces striped bass, as well as other anadromous species, is the rapid shrinkage of spawning and nursery rivers and estuaries being brought about by industrial expansion. This type of expansion is, of course, vital and must continue, but in many cases the stream conditions altered by industry can be made compatible with the spawning and maturing requirements of striped bass. Progress of this order is being made in some instances and is discussed later in regard to a specific case.

The above points appear to be those which are demanding the most immediate attention insofar as striped bass research is concerned. Future scientific programs designed toward obtaining such information will increase our knowledge of the dynamics of striped bass populations and consequently will benefit those engaged in the fishery.

STATUS OF BIOLOGICAL RESEARCH

Prior to 1952 there were several valuable investigative programs devoted to the study of the life history of striped bass. Raney (1952) reviewed publications resulting from these programs and summarized the research and conclusions of the various investigators. He also suggested lines of research to be followed in future programs. Merriman (1941) published his report concerning striped bass studies which were made on the Atlantic coast and which dealt with several aspects of striped bass biology. These reports, in our opinion, have become two of the more valuable contributions since they have served as bases for some of the current work on this species and define problems which are considered crucial now even after the lapse of several years.

In 1954, seven east coast states joined in a co-operative study under the name of the Atlantic States Cooperative Striped Bass Program. The individual projects of these states were financed largely through Dingell-Johnson funds and were designed to encompass a wide range of biological studies. Investigations were conducted in regard to the racial composition of populations; size, age, and sex composition; fecundity; food and growth; physiology; migrations; catch and effort; delimiting of spawning areas; morphology of young; the degree of competition between several forms of sport fishing; and landlocked populations of reservoirs.

Some of the above projects have been brought to completion. Some are still in progress and the results will be published. Unfortunately though, many were ill-fated as a result of insufficient funds and personnel and, in a few isolated cases, distinterest. The fact that effort expended in striped bass research has been reduced by the simultaneous study of other fish has also detracted from the program. Conclusions reached from the more productive studies under the co-operative program, in conjunction with the valuable knowledge obtained by such workers as Merriman (1941), Vladykov and Wallace (1952), Pearson (1938), Hollis (1952), Raney (1952), Lewis (1957), and others can be utilized in more detailed population analyses such as those now in progress in North Carolina and Chesapeake Bay. These analyses will form the basis for management recommendations.

The specific investigation with which the author is most familiar is that of North Carolina striped bass. This program was begun in 1955 as a co-operative venture between the U. S. Fish and Wildlife Service and twelve other state, federal, industrial and educational agencies. Current studies here are noteworthy because they involve problems similar to those existing in other segments of the striped bass range and because they exemplify the progress which can be made through unified effort.

The investigation was designed to evaluate the effect of industrial and domestic pollution of the spawning grounds in the Roanoke River, believed to be the dominant striped bass spawning area in North Carolina, determining: (1) the maximum concentration of pollution loads which would yet allow successful spawning; (2) minimum flow rates regulated by two recently constructed dams which would allow successful spawning as regards space and time requirements; (3) estimates of abundance in Albemarle Sound and in the spawning migration through tagging and recovery programs; and (4) the fishing intensity and spawning escapement in all areas concerned through the compilation of catch and effort data.

Even though all phases of the study are not yet complete, the population size, fishing rates and spawning escapement have been determined for each of two years; the spawning and nursery areas have been defined and flow requirements on the spawning grounds have been partially established.

Industrial officials in many instances show a willingness to co-operate in the maintenance of adequate physio-chemical conditions for fisheries when they are brought into close contact with fishery problems caused at least in part by the operation of their plants. In the Roanoke River situation, one of the primary manufacturing concerns involved has already, as a result of the fishery research program, installed expensive washing and recovery equipment for the reduction of pollutants and has contributed financial and scientific support to the study. Furthermore, the concerns which produce electric power have re-regulated flows during the striped bass spawning season at the request of scientific investigators. This action has constituted a direct financial contribution in the form of power loss. A weir has been constructed in the reservoir ahead of one of the dams to retain bottom water which is deficient in oxygen, and to draw only from the upper 25 feet of water as it moves into the forebay. The latter was done in an attempt to maintain dissolved oxygen above the minimum tolerance level of the migrating fish in the face of biochemical oxygen demand placed on the stream by industrial effluent. The weir was constructed at a cost of approximately a quarter of a million dollars.

After completion of the study, neither the fishery nor the industries involved will be able to operate exactly as they did prior to inauguration of the study, but it is anticipated that both will be able to exist compatibly with no great loss to either interest.

In the Albemarle Sound commercial fishery, which harvests some 600,000 pounds of striped bass annually, catches of all fishing gear have been sampled systematically for two and one-half years for the determination of size, age, and sex composition. One of the more urgent issues which has come to light in this phase of the study, and one which is being given particular emphasis by striped bass researchers, is that of determining the most advantageous age at which exploitation of the fishery should begin. Such an issue is frequent in our fisheries and always deserves careful consideration. The present fishery harvests fish chiefly in the 12- to 18-inch (fork length) size classes and in their second through fourth years of age.

During the period in which the Albemarle Sound fishery has been observed, it has been found that fish entering their second year represented 25 to 60 per cent of the total catch, varying with the fishing season. Gill nets dominate the fishery, and because of their range in mesh size (3¾ to 4¼ inches), they capture the two-, three-, and four-year-old fish in large numbers. Distribution of the nets is such that they take advantage of the age classes represented by the largest number of fish available at a particular time. For instance, small-mesh nets are employed more intensely than large-mesh nets during periods of a fishing season when availability of small fish is pronounced.

Among the minor gear, purse nets catch overwhelmingly two-year-old fish because the operation of this gear is designed to take advantage of the schooling tendency of the younger fish. Haul seines sample the entire range of age classes as they are distributed in the area of catch, and approximately one-third of the catches examined thus far have been composed of two-year-old fish. Pound nets take the two-year fish predominantly either because the older fish have little tendency to lead into traps or because their density in the pound net area (the eastern end of the sound) is not great enough to allow a significant harvest.

In view of the age classes available to and caught by the various gears mentioned, the question then to be considered is the effect that an increase in the age of initial exploitation would have on the fishery in future years. Merriman (1941) has shown that by shifting the first year of exploitation from the two- to the three-year class of fish, an increase results in pounds of fish, price per pound and, subsequently, in the total value of the fishery with no increase in expenditure of effort. Such a re-regulation in harvesting tactics in Albemarle Sound would very possibly result in at least a temporary increase in value of the striped bass, but its effect upon future abundance remains to be investigated. The magnitude of natural mortality and the amount of migration out of the sound occurring in fish after age two would, of course, have considerable bearing upon such a decision. If it were great, then a loss would result to North Carolina fishermen in failing to take advantage of the younger fish. The following analogy by Graham (1935) depicts the problem aptly: "For example, the hay crop of species maturing in different weeks must yet be cut at a certain age which takes advantage of as much growth as possible and avoids as much 'mortality' by seeding as possible."

Information furnished the legislator in regard to the management of striped bass populations therefore should not end in telling him that he can eliminate a given year class, and that it is then left up to him to decide how such action would benefit the fishery. He should also be informed as to how the change will affect subsequent populations and catches. Mathematical models have been and are being evolved which, when properly used, give a much more objective and accurate estimate of changes than has ever before been possibile. Such models are designed to be employed in the treatment of mass data analysis.

Problems exist in the Chesapeake Bay striped bass fishery which are somewhat analogous to these in North Carolina. Similar gears are employed in the two areas, and the size classes of fish caught are similar. Perhaps the greatest difference (and this is an assumed difference) between this fishery and the other one described, is that Chesapeake Bay contributes greater numbers of fish to areas outside of the Bay than does Albemarle Sound. It has been theorized that probably no more than 10 per cent of the stock migrates outside of the Bay, but that this migrating segment represents 90 per cent or more of the supply available to fishermen in northern coastal states. (Fishery Resources of the U. S., 1945). Merriman (1941) believed that the large group of two-year-olds observed in North Atlantic waters in 1936 were produced in 1934 in Chesapeake Bay. The findings of other workers supported this theory. Should this be the case, then some loss of fish outside of Chesapeake Bay might be expected by capture or natural mortality during migration away from and back to the Bay. Population density outside the Bay could at the same time be so reduced because of the extensive range of migration and relatively unrestricted area available to the fish, that this segment of the population could not be exploited to the best advantage. The extent of migration from the Bay has not yet been proven fully. This must be accomplished since conclusions from such a study will have bearing upon the manner in which Chesapeake Bay striped bass should be harvested.

A co-operative investigation of this fishery is now in effect between the States of Maryland and Virginia and the U. S. Fish and Wildlife Service. The program is designed to determine the degree of contribution of Chesapeake Bay stocks toward those of other areas and the effects of exploitation within the Bay on its own stocks. The co-operative program has been in effect for one year, and some 3,200 striped bass have been tagged, representing the largest simultaneous striped bass tagging operation in the history of Chesapeake Bay. From the low percentage of outside of the Bay recaptures, early indications from the tagging study are that the cotnribution by Chesapeake Bay stocks to the migrant populations of other areas is, in fact, a small fraction of those produced in Chesapeake Bay.

It is anticipated that upon completion of a few years' study of the Chesapeake Bay stocks and their relationship to other populations, solution can be reached for the problems involved here, and that a plan can be developed for the best utilization of the fishery.

SUMMARY

In this presentation I have attempted to define a few of the more outstanding problems existing among the Atlantic Coast striped bass fisheries and the methods being applied toward their solution. Much time and effort have been expended by researchers for the past several years in obtaining biological data which can, in conjunction with the results of present studies, be used to develop standards for the management of the fishery. Some assumptions have been made which require further research so that their accuracy may be accepted or rejected, and new problems requiring solution are constantly being produced by man-made environmental changes. Striped bass researchers now engaged in the study of population dynamics believe that with a continued comprehensive research program they will be able to suggest measures for the most efficient utilization of the striped bass resource.

After completion of the comprehensive study, the continuance of routine systematic collection of data in regard to catch, fishing effort, age, growth, and sex ratios is not only desirable, especially where there are significantly large populations, but is necessary for successful management. After management criteria have once been established,

the collection of such data yields high dividends for the time and cost involved.

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DISCUSSION

DISCUSSION LEADER FAHY: When the North Carolina cooperative phase of the striped bass program was set up, it was hoped at that time that it would serve as a model for such cooperative projects in the future, and that results would be commensurate with the effort. I believe that with the completion of its work in the fall of 1958, those hopes will have been realized. A large part of the credit for that will go to the personnel of the U. S. Fish and Wildlife Service at Beaufort, who, in the refinement of their methods of study of fishery population dynamics, have gone a long way toward pinpointing these populations and giving us these estimates in mortality.

THE STRIPED BASS IN RELATION TO THE MULTIPLE USE OF THE ROANOKE RIVER, NORTH CAROLINA

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The Roanoke River, a major coastal stream of North Carolina, originates on the eastern slopes of the Appalachian Ridge, traverses through the rolling Piedmont Plateau, descends the Atlantic Coastal Plain, and debouches into Albemarle Sound through several channels. A descent of 2,900 feet occurs in the 410 miles from the headwaters to the estuary. The drainage basin of the Roanoke covers approximately 9,600 square miles of which two-thirds are in Virginia and one-third is in North Carolina.

As the population and economy of North Carolina increase, augmented and varied demands are imposed on its rivers. The Roanoke River annually sustains spawning migrations of anadromous fishes which contribute chiefly to the commercial catch at present, but the sport fishery is increasing and its potential value is great. In recent years privately owned and federal hydroelectric installations have been constructed both for flood control and for the production of electrical energy required by growing industries and municipalities. Many of these industries and municipalities have long used the flowing river for process water and for an economic and convenient assimilator of wastes.

The multiple use of the Roanoke River involves these three major interests: hydroelectric power development, industrial and municipal waste disposal, the striped bass fishery and the resident fishes. The water requirements of the three major users of the Roanoke River conflict to the extent that all three users cannot have their needs supplied simultaneously. Any two of the three interests, however, may have their water requirements supplied simultaneously, but only at the expense of the third party. Each of the conflicting interests represents a renewable, natural resource. The fishery produces an annual harvestible crop which may be sustained by good management; the hydroelectric impoundments produce an annual supply of energy by their manipulation and control of the natural supply of water; and the large industries located along the river harvest and process a renewable crop of timber which under scientific management is becoming the most important southern crop. Since each of these resources contributes to the economy of the state, it is essential that these interests integrate their needs and resolve their problems so that the greatest benefit may be obtained from the river. In order to protect the striped bass fishery, a

Steering Committee for Roanoke River Studies composed of representatives of federal, state, and private agencies, industry, private utility companies, sport and commercial fishing interests, and private citizens is endeavoring to adjudicate the resources of the river to the needs of each user and to the ultimate benefit of the people of North Carolina.

FISHING

The spawing migration of anadromous fishes up the Roanoke River during the spring is of considerable magnitude and is eagerly exploited by residents of the valley and vicinity. The striped bass (*Roccus saxatilis*) of the North Carolina coastal sounds migrate chiefly up the Roanoke River to spawn. Small numbers of striped bass, however, also migrate up other coastal streams in North Carolina, such as the Cape Fear, Tar, and Neuse Rivers. In addition to the striped bass, enormous numbers of alewives (*Alosa pseudoharengus*), glut herring (*Alosa aestivalis*), and white perch (*Morone americana*) swarm up the Roanoke and much of the fish catch consists of these species. A small number of American shad (*Alosa sapidissima*) also migrate up this stream. In the late spring white catfish (*Ictalurus catus*), channel catfish (*Ictalurus punctatus*), brown bullheads (*Ictalurus nebulosus*), carp (*Cyprinus carpio*), and other fish spawn in the lower Roanoke. Densely packed schools of young menhaden (*Brevoortia tyrannus*) also utilize the lower regions of the river during their freshwater sojourn.

In recent years considerable public concern has been expressed over the catch of striped bass in the Roanoke River. The impression is widespread that this fishery is in a state of decline and that a considerable decrease in catch has occurred during the last decade. There are no available catch records of the sport fishery to indicate any change or decrease in this catch. The U. S. Fish and Wildlife Service is cur-

TABLE 1. COMMERCIAL CATCH OF STRIPED BASS IN NORTH CAROLINA, 1887-1957

Year	Quantity in Pounds (000)	Year	Quantity in Pounds (000)	Year	Quantity in Pounds (000)
1887	500	1928	507	1945	609
1888	560	1929	246	1948	500
1889	531	1930	457	1949	797
1897	845	1931	326	1950	797
1900	568	1932	507	1951	702
1902	1,175	1934	362	1952	647
1908	510	1936	768	1953	757
1918	286	1937	713	1954	1,122
1923	477	1938	523	1955	736
1957	738	1939	339	1956	764
		1940	540	1957	597

From reports of the U. S. Fish Commission, Bureau of Fisheries, and the Fish and Wildlife Service.

rently making a population census of spawning striped bass and a creel census of the catch in the river. This is the first attempt to record these data on the Roanoke. The available statistics for the commercial fishery do not indicate any progressive decline in the total annual catch of striped bass over the past seventy years. These data are presented in Table 1. Records of the amount of gear used, however, are insufficient or unavailable for the commercial fishery over this period of time. Thus, it is not possible to calculate the catch per unit effort for these years.

HYDROELECTRIC IMPOUNDMENTS

The record flood of 1940 instigated an investigation for flood control in the Roanoke River Basin by the Corps of Engineers, U. S. Army. Subsequently, the District Engineer recommended the construction of the John H. Kerr Dam at river mile 179.5. This dam was proposed as a multi-purpose impoundment and was authorized by Congress primarily for flood control and generation of hydroelectric power. Unevaluated benefits included recreation, pollution abatement, navigation, water supply, and fish and wildlife preservation. The dam was completed in 1952 and created a storage reservoir of approximately 49,000 acres. The hydroelectric facilities have been operated for peak-power production during the hours of greatest demand. During the off-peak hours the water releases are limited to the authorized minimum flow releases, except during the striped bass spawning season when minimum flows have been voluntarily augmented by the Corps in accordance with the recommendation of the Steering Committee. The Corps of Engineers, the operators of the dam, and the Southeastern Power Administration, the marketing agency for the power, strive to keep off-peak water releases to the minimum in order to conserve water for hydroelectric generation during hours of optimum rates and to insure fulfillment of power contracts throughout the year.

In 1951 a private utility company was granted a license to construct a hydroelectric dam just upstream from Roanoke Rapids at river mile 137.5. This impoundment was completed in early 1955 and power generation commenced in July 1955. The Roanoke Rapids Dam impounds approximately 4,900 acres and its peaking operation must be coordinated with the water releases from Kerr Dam because of its small capacity. The operators of this installation also find it necessary and expedient to maintain minimum water relases during the off-peak periods.

A. Minimum Flow.

The minimum flow releases from Kerr Dam and Roanoke Rapids have been a point of contention since the construction of these impoundments. These flow releases are the same for both impoundments, since the Roanoke Rapids Dam must re-regulate its output in conformity with the releases from the upstream storage impoundment. The minimum flows from Kerr Reservoir were approved by the U. S. Fish and Wildlife Service in the report of May 1946. Congress approved these minimum releases in the authorization of House Document No. 650, Seventy-eighth Congress, second session. The Federal Power Commission's stipulations for minimum flows from the Roanoke Rapids Dam are outlined in Table 2. The special provisions for striped bass in Table 2 provide for minimum flows of 2,000 c.f.s., which is equivalent to a gauge height of 10.8 feet on the striped bass spawning area near Weldon, N. C. Considerable concern was expressed subsequent to the installation of the dams that striped bass spawning would be eliminated or curtailed by minimum water releases. It was also feared that industrial and municipal wastes would have deleterious effects on striped bass eggs and larvae. It was also believed that high

TABLE 2. ROANOKE RIVER MINIMUM FLOWS

	FPC License Stipulations for Roanoke Rapids Dam				Steering Committee Recommendations*	
	Week-day		Week end			Stage in feet
	c.f.s.	feet	c.f.s.	feet	c.f.s.	at Weldon
January to April, inclusive	500	(9.1)	500	(9.1)		
January through April					1,000	(9.8)
May	1,250	(10.1)	600	(9.3)	1,250	(10.1)
June to August, inclusive	2,000	(10.8)	1,000	(9.8)		
June through September					2,000	(10.8)
September	1,600	(10.4)	800	(9.6)		
October	1,250	(10.1)	600	(9.3)	1,600	(10.4)
November and December	500	(9.1)	500	(9.1)	1,000	(9.8)
*Based upon water of 90% D.O. saturation or higher.						
Special Provisions for Striped-Bass						
For not more than 75 days in any one year and between Mar. 15-April 15 and May 15-June 15 and upon recommendations of NCWRC	2,000	(10.8)	2,000	(10.8)		
A. Daily water levels reaching 25′ March 21 through March 25					15,000	(25)
B. Following (A), minimum of 13′ and maximum of 19′ until May 16 except as modified by (C)					5,500 13,400	(13) (19)
C. A minimum of 15′ and maximum of 19′ during spawning season (two weeks) upon request of NCWRC					8,350 13,400	(15) (19)

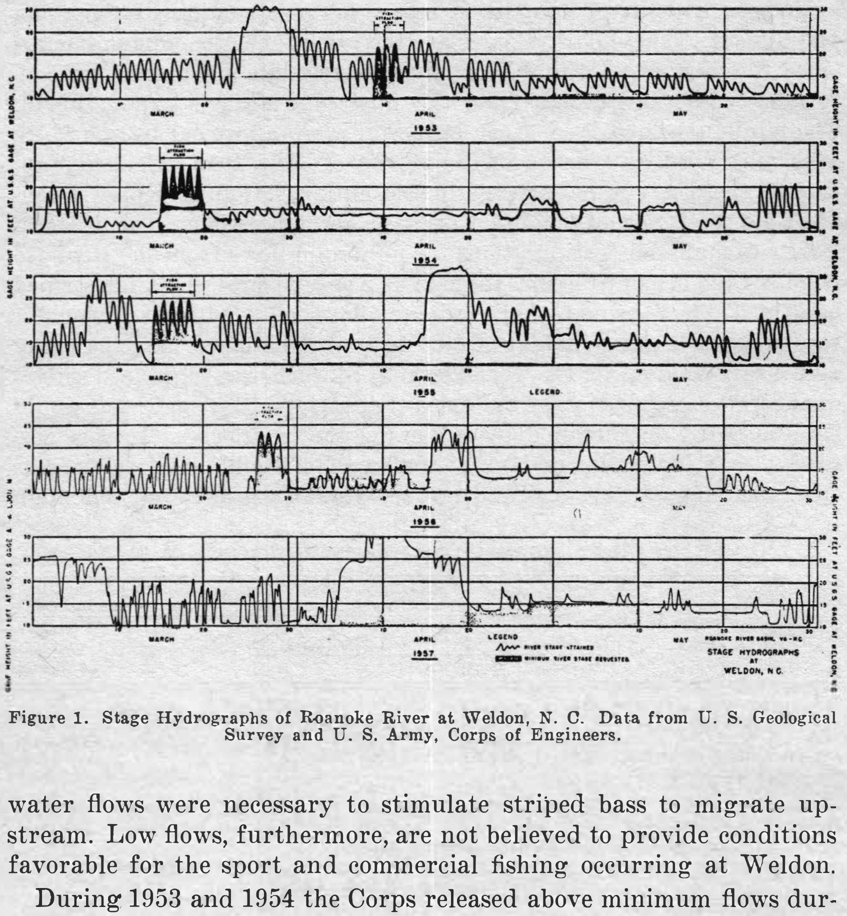

Figure 1. Stage Hydrographs of Roanoke River at Weldon, N. C. Data from U. S. Geological Survey and U. S. Army, Corps of Engineers.

water flows were necessary to stimulate striped bass to migrate upstream. Low flows, furthermore, are not believed to provide conditions favorable for the sport and commercial fishing occurring at Weldon.

During 1953 and 1954 the Corps released above minimum flows during the striped bass's spawning season at the request of State and Federal agencies. The Steering Committee for Roanoke River Studies adopted a schedule of minimum flow requirements in July 1955. These recommended flows are outlined in Table 2. The Corps of Engineers. U. S. Army, and the operators of the privately owned Roanoke Rapids Dam have subsequently regulated their minimum flow releases during the striped bass spawning periods in accordance with this schedule. A special release of water purported to be an "attraction flow" was provided during 1953 through 1956. Since the release of large volumes of water is usually necessary to keep within the rule curve, this flow was not requested in 1957. Figure 1 depicts stage hydrographs of river flows during the spawning season from 1953 to 1957. The Corps of Engineers have provided the increased flow since 1955 by these operations:

1. Modification of the rule curve of operation during the requested study period by the increased storage of two feet of water in the lower part of the flood pool before the start of the striped bass spawning season.
2. The release of the stored water impounded above the rule curve during the striped bass season to increase minimum flows on the spawning grounds and to maintain power requirements during this period.

These temporary modifications in operation at Kerr Dam have resulted in a reduction of flood control capacity of the reservoir during this period and in a minor loss in revenue from the sale of power.

In reference to the minimum flow release of 2,000 c.f.s., it should be noted that the daily water level of the Roanoke River at Weldon has not descended to this level for a single day during the spawning season (April 15 to May 14) in the preceding 40 years of record. The daily records of the U. S. Geological Survey from 1912 to 1951 show that the lowest daily flow was 2,310 c.f.s. (11.0 feet) on May 14, 1942. These daily averages are tabulated in Table 3. The same records, however, show that a flow of 5,550 c.f.s. (13.0 feet) would not be attained approximately 29 per cent of the time during this period. Likewise, a flow of 8,210 c.f.s. (15.0 feet) would not be attained approximately 63 per cent of the time. The latter two stages, 13 feet and 15 feet, are the stages requested by the Steering Committee. Thus, it appears that a compromise should be effected between the minimum flow release of

TABLE 3. WATER STAGES OF ROANOKE RIVER AT WELDON, N. C., DURING STRIPED BASS MIGRATION AND SPAWNING SEASON, APRIL 15-MAY 14, INCLUSIVE*

Daily Discharge c.f.s.	Weldon Stage feet	Frequency of Days at Indicated Flow	Per Cent Frequency	Cumulative Per Cent Frequency
1671–2310	10.5–11.0	1	0.1	0.1
2311–3070	11.1–11.5	13	1.1	1.2
3071–3890	11.6–12.0	66	5.5	6.7
3891–4740	12.1–12.5	112	9.3	16.0
4741–5550	12.6–13.0	156	13.0	29.0
5551–6300	13.1–13.5	138	11.5	40.5
6301–7000	13.6–14.0	101	8.4	48.9
7001–7690	14.1–14.5	96	8.0	56.9
7691–8210	14.6–15.0	83	6.9	63.8
8211– +	15.0– +	434	36.2	100.0
Total		1,200	100.0	

*Total number of days during the 40-year period of record (1912-1951) prior to flow regulation by John H. Kerr Dam on which the daily river discharge at Roanoke Rapids gauge (1932-1951) and Old Gaston gauge (1912-1931) occurred between the indicated limits.

2,000 c.f.s. authorized for the hydroelectric dams and the temporary flow of 8,210 c.f.s. recommended for the study period.

The existing schedule of minimum flows authorized by the Federal Power Commission provides for a reduction in minimum flows over the week-end. These reductions in flow were originally based on the assumption that industrial wastes and municipal sewage would be decreased over the weekends; however, this is not the situation since large industries operate seven days a week. The discharge of sewage into the Roanoke is also continuous. Obviously, there is no apparent justification for the reduced weekend flows, since waste loadings are not appreciably curtailed during that period. Consequently, the Roanoke River Steering Committee has recommended the elimination of reduced minimum flows over Saturdays and Sundays. An increase in minimum flows from October through April has also been recommended by this committee.

It is speculated that certain changes must occur in the present operating procedures on the Roanoke River to provide for the multiple use of this resource in an equitable manner. The apparent changes necessary are:

1. Pollution abatement by industries and municipalities. (The North Carolina Stream Sanitation Committee has already notified each polluter as to pollution abatement needs.)
2. Congressional authorization to modify the Kerr Reservoir rule curve of operation and minimum releases, plus a re-evaluation of project benefits and a revision of the amortization schedule.
3. An increase in the minimum flows released from Roanoke Rapids Dam. This increase would involve a revision in the license for this project from the Federal Power Commission.

The revision of the minimum flows existing in a license issued by the Federal Power Commission may be the most crucial point in the entire Roanoke River Study. If a voluntary and reasonable solution to the minimum flow problem does not occur, a review by the Federal Power Commission may be requested. The revision of the terms of an issuing license by the Federal Power Commission would establish a precedent which would affect every power company in the country. Private or corporate utility companies would undoubtedly oppose such an innovation in procedure.

B. Dissolved Oxygen.

The turbines at Kerr Dam have low-level intakes which draw water from the lower third of the reservoir which stratifies approximately seven and one-half months a year. During the late summer months,

TABLE 4. DISSOLVED OXYGEN CONTENT AND PER CENT SATURATION OF ROANOKE RIVER AT NO. 48 HIGHWAY BRIDGE BEFORE (1953) AND AFTER (1956) CONSTRUCTION OF ROANOKE RAPIDS DAM[1]

Year	D.O. p.p.m.				Per Cent Saturation			
	Sample Number	Mean	Std. Dev.	"T" Test	Sample Number	Mean	Std. Dev.	"T" Test
1953	51	7.91	0.49		50	94.84	6.99	
1956	64	5.68	0.86	3.12**	64	65.63	9.48	3.44**

[1]Data from N. C. Stream Sanitation Report (1956) and Halifax Paper Co.

the water released from the hypolimnion is low, or devoid of, dissolved oxygen. Studies made by the U. S. Public Health Service in 1953 showed that reaeration of these water releases required a stream distance of approximately 42 miles, which is almost the distance to Roanoke Rapids. Under these conditions the dissolved oxygen levels were eventually restored to levels sufficient to provide for assimilation of downstream wastes.

Since the commencement of operations at Roanoke Rapids Dam, the dissolved oxygen levels at river mile 135 have been considerably reduced during July, August and September. Table 4 shows the significant change in dissolved oxygen values and the per cent saturation of Roanoke River water before and after the construction of the Roanoke Rapids Dam. The lower dissolved oxygen values resulting from this impoundment are attributed to:

1. Stratification and decomposition of organic material in the reservoir.
2. A deeply excavated tailrace which minimized the natural gradient of the stream at this point and reduced the former turbulence occurring here.
3. The use of low level intakes to the turbines.

At the present time, the operators of the Roanoke Rapids Dam are applying for a license from the Federal Power Commission to build another impoundment at river mile 144.9. Since this impoundment will back water to the base of Kerr Dam, a series of impoundments approximately 83 miles long will be formed on the Roanoke River. This proposed dam will probably result in further deterioration of water quality and affect downstream users during late summer, because it will eliminate much of the turbulence and reaeration now occurring downstream from Kerr Dam. If construction of this dam is authorized, it is expected that appropriate facilities will be installed to prevent the discharge of water low in dissolved oxygen.

The North Carolina Stream Sanitation Commission (1956) recognizes that, "Even though a hydroelectric project adds no pollutants to

TABLE 5. DISSOLVED OXYGEN CONTENT AND PER CENT SATURATION OF ROANOKE RIVER AT NO. 48 HIGHWAY BRIDGE BEFORE (1956) AND AFTER (1957) CONSTRUCTION OF SUBMERGED WEIR AT ROANOKE RAPIDS DAM[1]

Year	D.O. p.p.m.				Per Cent Saturation			
	Sample Number	Mean	Std. Dev.	"T" Test	Sample Number	Mean	Std. Dev.	"T" Test
1956	64	5.68	0.86	0.45	64	65.63	9.48	0.50
1957	47	6.07	0.88		46	70.74	11.23	

[1]Data from Halifax Paper Co.

the water, it may from the standpoint of altering water quality be equivalent to a source of pollution.''

In an effort to increase the dissolved oxygen content of the water released from the Roanoke Rapids Dam, the operators constructed a submerged weir in front of the turbine intakes. This weir extended within 25 feet of the surface and was designed to draw the upper layers of water through the turbines. Vacuum breakers were also used in the turbine intakes during the Summer of 1957. The resulting dissolved oxygen values at river mile 135 during July, August and September 1957 are given in Table 5. Comparison of the dissolved oxygen and per cent saturation in the Roanoke River downstream from the Roanoke Rapids Dam before and after the construction of the submerged weir does not indicate any significant difference in content. The downstream users of the river must comply with the minimum standard of 4.0 p.p.m. of dissolved oxygen as required by the North Carolina Stream Sanitation Committee. The apparent failure of the submerged weir to restore the dissolved oxygen content to pre-impoundment levels means that the downstream users have lost approximately 47 per cent of the dissolved oxygen assets from 4.0 to 7.9 p.p.m.

INDUSTRIAL AND MUNICIPAL USE

The North Carolina Stream Sanitation Committee (1956) has estimated the total sewage and waste load of the lower Roanoke River to have a population equivalent of 622,500 of which 597,000 is attributed to industrial effluent. The industries discharging wastes into the Roanoke River include several textile mills, two plywood plants, food processing and packing plants, and two large kraft-pulp mills. All of the communities bordering the Roanoke discharge untreated sewage into the river.

The two kraft-pulp mills discharge the greatest amount of oxygen-demanding wastes occurring in the river. Since a river distance of approximately 125 miles intervenes between these mills, there is no cumulative effect from their wastes. The upstream mill is located at river mile 134. Production initiated in 1909 made this the first kraft mill in the United States. The effluent of this mill is discharged just upstream from a major spawning area and has instigated concern over its effects on striped bass eggs and larvae. The other paper mill was constructed in 1938 and is located 9 miles above the mouth of the river. The effluent from this plant is discharged in a small tributary of the Roanoke River.

Both of these mills use the alkaline or sulfate process for pulping wood. The economic advantage of this process is the ease of recovery of cooking chemicals. Evaporation and combustion processes recover chemicals for re-use, burn waste carbohydrates, and provide heat energy. Even with highly efficient recovery systems, however, the large volumes of dilute wastes may impose pollution problems when the river flow is reduced or affected by wind tides.

The North Carolina Stream Sanitation Committee (1956) classification for fishing requires a minimum of 4.0 p.p.m. of dissolved oxygen in the Roanoke River, except in the downstream region where a swamp water classification of 3.0 p.p.m. prevails. Recently, this Committee enacted a pollution abatement plan which requires industry to provide treatment facilities, to limit waste discharge to specified loadings, and to discharge wastes in proportion to stream flow. Sewage plants have also been required of municipalities.

The analysis of kraft mill effluent by Van Horn, Anderson and Katz (1950) identified certain components to be toxic to fish at low concentrations. Methyl mercaptan, various sulphides and acid resin soaps were the most toxic components and these substances were found to have minimum lethal concentrations[1] of 0.5 p.p.m. 1.0 p.p.m., and 1.0 p.p.m., respectively. Subsequently, Gehm (1953) reported that sulphides and mercaptans were quickly destroyed on contact with dissolved oxygen contained in the receiving waters and that these substances were seldom detectable, except at the point of discharge. Gehm (*loc. cit.*) also concluded that the content of acid resin soaps from a modern mill is reduced sufficiently to avoid toxic conditions when diluted in a ratio of 1 to 20 or greater.

Allerdice and Brett (1957) calculated that mortality would not occur in sockeye salmon under-yearlings when kraft mill effluent was diluted in a ratio of 1 to 21 or higher. This is equivalent to a dilution of 4.8 per cent effluent with confidence limits of 4.0 and 5.4 per cent.

Alderdice and Brett (*loc. cit.*) presented experimental evidence that the respiratory requirements of sockeye salmon under-yearlings were

[1]The minimum lethal concentrations in these studies were defined as: "the lowest concentration of a toxic material which would kill any of the test animals within 120 hours, when held in a test solution at 18° C. . . ."

increased as the concentration of kraft mill effluent increases. The concentration of effluent at which oxygen availability was a limiting factor was calculated to be 2.5 per cent or a dilution ratio of 40 to 1. During the striped bass spawning season in the Roanoke River, the dissolved oxygen content of the river is not a limiting factor and the dilution of waste is considerably above the proposed 40 to 1 ratio. A theoretical dilution of approximately 307 to 1 is attained at the recommended 15 foot stage and approximately 207 to 1 at the 13 foot stage. Bioassays also confirm subdetectable concentrations or absence of toxicants under existing Roanoke River conditions during the striped bass season.

TURBIDITY

Before the construction of the upstream impoundments, the Roanoke River conveyed enormous loads of red silt downstream into Albemarle Sound. Smith (1907) reported that the muddy waters of the Roanoke River were visible 40 miles from its mouth. Turbidity readings in the Roanoke often attained values of 3,000 to 4,000 p.p.m.

A considerable reduction in turbidity has been apparent in the Roanoke River since the construction of the upstream dam. In Table 6 the averages of monthly turbidities recorded during the ten-year period prior to the dams, and for six years after their installation, confirms this great decrease in turbidity. The maximum turbidities have been reduced the greatest amount, and the average for July shows a reduction of 95 per cent for post-impoundment turbidity. Every month showed a reduction in maximum turbidity of at least 80 per cent. The average of the monthly turbidity readings in Table 6 has also been sharply reduced since 1951. Formerly, water turbidity in the Roanoke soared during the months of May, June, July and August. These high readings did not result from an increase in the rate of water discharge since the flow is comparatively low in the Roanoke during this time of year. Apparently, thunderstorms and an increase in agricultural activities during these months caused the increased silt

TABLE 6. MONTHLY AVERAGES OF ROANOKE RIVER TURBIDITY DETERMINATIONS BEFORE (1942-51) AND AFTER (1957-57) IMPOUNDMENT[1]

		Turbidity in p.p.m.											
Years		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1942 to	Aver. max.	1235	967	1283	1207	2190	2200	2340	1380	1272	690	680	502
1951	Aver.	187	199	231	205	505	591	815	435	267	162	129	104
1952 to	Aver. max.	119	192	226	84	144	286	91	84	117	72	88	59
1957	Aver.	46	65	78	56	62	67	53	49	43	36	35	33

[1]Turbidity data from Roanoke Rapids Sanitary District Records.

load. At the present time, the reservoirs are serving as settling basins for the suspended solids. The hydroelectric potential, however, will be diminished only a slight percentage by siltation over a fifty-year period.

Since striped bass spawn in the Roanoke River during late April and early May, the critical early life history stages formerly occurred during the months (May-August) when the water turbidity was highest. The relatively low turbidities now occurring in the Roanoke River should improve the survival rate and growing conditions for larval striped bass in western Albemarle Sound. The increase in water transparency and possible decrease in nutrient loss by sedimentation are distinct environmental improvements.

Some changes in fishing success have occurred with the great decline in turbidity. Bow net fishermen are experiencing difficulty in capturing striped bass during daylight hours. This lack of success has been attributed to the increased transparency of the water. This increased transparency, however, apparently accounts for an increased catch of striped bass by artificial lures and bait which is now occurring.

SUMMARY

Hydroelectric dams, municipal growth and industrial expansion have altered the volume and quality of water in the Roanoke River. A Steering Committee representing State and Federal agencies, hydroelectric operators, industry and fishermen is endeavoring to protect the striped bass fishery and to adjudicate the resources of the river for multiple use. Chemical, physical and biological studies are being conducted by the various agencies involved.

The commercial striped bass fishery in North Carolina shows annual fluctuations in catch, but there is no evidence of a progressive decrease in catch over the past 70 years.

Reservoir stratification and low-level turbine intakes have resulted in a decrease in the dissolved oxygen content of water releases. A submerged weir has been constructed by a private utility company to increase the oxygen content of water releases.

The North Carolina Stream Sanitation Committee has enacted a pollution abatement plan in order to protect striped bass and to sustain additional development of the river.

Kraft-pulp mill waste imposes an oxygen demand on the river, but the toxicity of this effluent to striped bass is avoided by an efficient recovery process and dilution by receiving waters at existing flows.

The construction of hydroelectric impoundments on the Roanoke River has considerably decreased water turbidity downstream from the dams.

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DISCUSSION

MR. ROBERT M. PAUL [Sport Fishing Institute, Washington, D. C.]: I would like to know if the mortality of striped bass is affecting the reproduction of the bass in any way? What is the D. O. during the spawning season?

DR. HASSLER: The low D. O. I spoke of, occurs during the late summer and early fall. During the spawning season, the oxygen is seven parts per million or higher. Low D. O. has caused fish kill where we have had reduction of flow over the week end. Normal loadings have been imposed on the river and then when generation of power started after a long week end, release of water from the lower zone of the reservoir has caused fish kills; however, I believe last year the hydroelectric operators voluntarily increased the week end flows and we have not had serious fish kills for that year but the D. O. during the spawning season is about 7 to 8 parts per million and temperatures are quite cold.

MODERATOR FAHY: What would you consider the most critical stage in the life history of the striped bass in the Roanoke River?

DR. HASSLER: I would consider the most critical stage, the transport of striped bass larvae from the river 60 miles downstream to the nursery areas in Albemarle Sound. There is a gradient of only two feet in the last 60 miles. The river channel increases from an average width of 250 to about 550 feet in the last 30 miles. Quite often, when we have strong east or northeast winds, there is a lack of current in the lower part of the river. Occasionally I have not been able to detect any current. There is a strong possibility that under those conditions striped bass larvae may be deposited on the river bottom in silt or mud.

DR. CHARLES S. COLE [University of Arkansas, Fayetteville, Ark.]: What would you consider to be an equitable solution to the general problem as it stands right now?

DR. HASSLER: I think that is already in progress in North Carolina. The State Stream Sanitation Commission allocated B.O.D. loadings to the various users of the river. They are also requiring polluters to discharge their waste in proportion to river flow. They have also requested waste-treatment facilities to be constructed and sewage plants are now required of all municipalities on the river.

To answer this problem completely, I think we would have to have a revision in the rule curve of the Corps of Engineers' dam and a revision of the minimum flows. If that occurred, of course, it would require a re-evaluation of the project benefits of the dam and a revision of the schedule of amortization. That will require Congressional authorization.

The crux of the whole problem would be that the private utility company consent to increase its minimum flows. If they do not, a request will have to be made of the Federal Power Commission to increase these flows.

DR. ALBERT S. HAZZARD [Pennsylvania Fish Commission, Lemoyne, Pa]: I would like to take advantage of this opportunity to address a question to the panel of the experts on the striped bass. Pennsylvania for some years has had an 18-inch size limit on the striped bass, whether taken in or out of the state, and that means that Pennsylvanians very seldom have a chance to eat striped bass from the commercial markets. Is there any justification for a size limit of that type in Pennsylvania or elsewhere?

MR. SYKES: I hesitate to answer that question and I don't feel that I can do so adequately. I know the size limit has been kicked around for quite some number of years and I don't think there has ever been any real solution that has come from scientific evidence for any particular size class.

I will stick to my point that we need more thorough investigation of what happens over a period of years. Actually, I don't know of any real basis for establishing an 18-inch size class on striped bass.

CHAIRMAN RANEY: Dr. Hazzard, I would like to comment briefly on this problem. As I understand it, it is 18 inches in Pennsylvania. Well, if this is so, I assume it is over-all length and that is two inches longer than the limit imposed by any other state, with the possible exception of California. I am not up to date on their figures. In New York, we have a 16-inch fork-length limit. The importation of striped bass is permitted from the Chesapeake Bay area, where, in Maryland and Virginia, I believe the limit is 11 and 12 inches respectively. And I should not see why the people of Philadelphia and the other large areas of Pennsylvania should be prohibited from eating this fine fish, which is excellent at a size of 12 inches.

I would like to ask Bill Hassler a question about the report that striped bass have been taken recently in the Kerr reservoir, which is one of the impoundments on the Roanoke River. I know this is a question a great many people are interested in. There is a possibility of introducing the striped bass into and maintaining populations in fresh waters, especially after the work that has been done in South Carolina, which shows a very large population present and self-sustaining.

DR. HASSLER: About a year ago, Dr. Raney, I had one specimen of striped bass brought in to me for identification and evidently some spawning had occurred in Kerr Reservoir. This year, I heard numerous reports. I have not seen any specimens, however. There seems to be widespread talk among the people in that area that these fish are spawning.

One thing, which may be a discordant note, is that the private power companies are considering construction of more dams upstream from Carr Reservoir, which of course, would block access to spawning grounds in that area.

MR. BERNIE CARTER [Kentucky Department Fish and Wildlife, Frankfort, Ky.]: I have also heard those reports and I guess they are fairly authentic because, if I am not mistaken, Bob Martin, from Virginia, told me they had picked up young striped bass in Kerr Reservoir, and in Kentucky, we have obtained some of the fish and have stocked them in our Cumberland Lake. We don't know, of course, how it will work out, but are going to continue to stock them. I think everybody is more or less interested in that.

DR. HASSLER: One comment on the Kerr Reservoir striped bass. I would estimate that 90 per cent or more are in Virginia, and we just have a small arm in North Carolina. So the reports we have emanate from Virginia.

MR. RAYMOND MARTIN [Arkansas Game and Fish Department, Texarkana]: Do you know how far the fish from Kerr Reservoir move upstream to spawn?

DR. HASSLER: I am not particularly familiar with that area. But I think that they would have to go at least 60 miles upstream. That is an estimate, sir.

DIFFERENCES IN THE ESTUARINE ECOLOGY OF FLORIDA WATERS AND THEIR EFFECT ON POPULATIONS OF THE SPOTTED WEAKFISH, *CYNOSCION NEBULOSIS* (CUVIER AND VALENCIENNES)[1]

DURBIN TABB

The Marine Laboratory, University of Miami, Miami, Florida

The state of Florida is the locale for extensive sport and commercial fisheries. With few exceptions these fisheries depend on species which require inshore waters for some stage of development. The value of the shallow water environment is further enhanced by its accessibility.

The promise of good fishing has helped to lure visitors to the state for many years. Furthermore, since World War II, increasing numbers of residents and visitors have put pressure on the fish stocks and have accelerated the changes in the estuarine environment so vital to the continuing existence of these stocks. It is apparent that a continued expansion of human population will further encroach on the already limited inshore environment.

It is up to the biologist to determine the effects upon the environment of such development and to help insure that as much of our fishing as possible is retained, consistent with necessary land development.

Studies of a biological nature are being conducted by various state and federal agencies. Unfortunately, such investigations, if they are to be of value, require a great deal of time. Meanwhile, great changes are taking place without the advantage of biological information to minimize the adverse effects on fish stocks.

A survey of the biology and ecology of the spotted weakfish was begun in 1955 under the auspices of the Florida State Board of Conservation and some of the findings illustrate the influence which estuarine ecology exerts on this valuable species.

The spotted weakfish was chosen for study because it is almost entirely restricted to the inshore environment. It is a prime sport and commercial species, and there are indications that a biological decline may have taken place.

Statistics from the commercial fishery for spotted weakfish in Florida are available since 1950 and show an average production during this period of about 3.5 million pounds. No reliable statistics are available for the sport fishery but there are indications from several independent unpublished investigations that this catch nearly equals that of the commercial fishery. In some Indian River areas this commercial fishery has been displaced by the sport fishery. In such areas

[1]Contribution from The Marine Laboratory, Univ. of Miami.

no longer utilized by gillnetters, most of the "commercial" landings are made by sportsmen. The monetary value of such fisheries, plus the harder-to-define recreational advantages provided are large and certainly worthy of conservation.

The purpose of this report is twofold. It attempts to define some aspects of the ecology which combine to form ideal living conditions for the spotted weakfish. It attempts, by comparison, to show the results of variance from ideal conditions on the abundance and biology of the species.

VARIATIONS IN ENVIRONMENT

The spotted weakfish, a member of the family Sciaenidae, (which includes croakers, drum, channel bass and other weakfishes) is found throughout the southeastern United States from New York to Texas (Jordan and Evermann, 1898). There are few places within this range where the species does not support some sort of fishing activity and weakfish occur in varying numbers in nearly all types of inshore environment. There are areas within the range of the species, however, where population density is relatively high and which have been capable of supporting heavy, sustained fishing pressure.

The present paper discusses aspects of the ecology of spotted weakfish which appear to have direct bearing on success or failure of this

TABLE 1. LANDINGS OF SPOTTED WEAKFISH BY COUNTY IN FLORIDA FOR THE YEAR 1955[1]

East Coast (north to south)		West Coast (north to south)	
County	Production in pounds	County	Production in pounds
Nassau	....	Escambia	25,771
Duval	13,383	Santa Rosa	....
St. Johns	....	Okaloosa	12,634
Flagler	....	Walton	
Volusia	99,335	Bay	71,981
Brevard	408,502	Gulf	
Indian River	218,166	Franklin	150,245
St. Lucie	117,639	Wakulla	16,827
Martin	34,615	Jefferson	....
Palm Beach	1,557	Taylor	81,652
Broward	....	Dixie	61,615
Dade	27,607	Levy	88,546
Monroe	25,871	Citrus	108,205
		Hernando	22,010
		Pasco	
		Pinellas	231,210
		Hillsborough	100,913
		Manatee	95,063
		Sarasota	35,807
		Charlotte	218,207
		Lee	533,883
		Collier	120,470

[1]"Florida Landings" Florida State Board of Conservation, 1956.

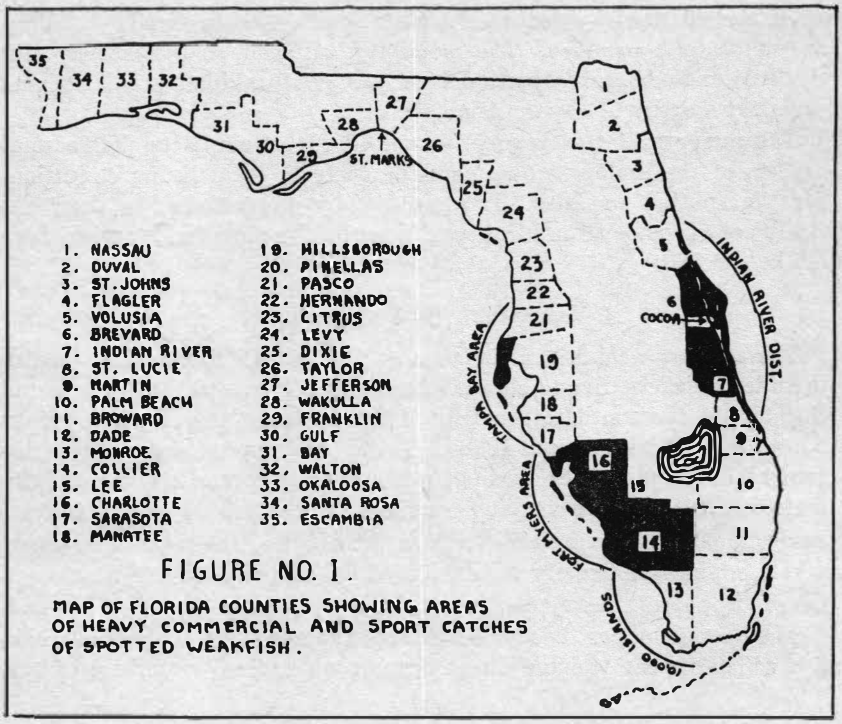

FIGURE NO. 1.

MAP OF FLORIDA COUNTIES SHOWING AREAS OF HEAVY COMMERCIAL AND SPORT CATCHES OF SPOTTED WEAKFISH.

species. Results given are largely based on observations and data gathered during a survey of the biology of the spotted weakfish from the Indian River district of eastern Florida. (Figure 1.) This system of brackish lagoons is the result of off-shore sandbar formation. A conspicuous feature of the long, narrow lagoons is the limited number of outlets to the sea. There are only three such outlets in a distance of about 150 miles of coastline between New Smyrna Beach and Fort Pierce, Florida.

A fishery of one type or another has existed in the Indian River district since the Civil War. The spotted weakfish has figured prominently in these fisheries and the presence of large catches and larger than average individuals have made the area a sport fishing center.

Ecological conditions in the Indian River area apparently approach the optimum for the species and this region has been used as a basis for ecological comparison with other areas.

Although three closely related weakfishes, *Cynoscion regalis, C. nothus* and *C. arenarius* are found within the range of the spotted weakfish the former three species are essentially marine (Breder, 1948; Ginsberg, 1929; Jordan and Evermann, 1898). The spotted weakfish, while showing limited affinity to a truly marine environment, is essentially an estuarine species. (Gunter, 1945; Pearson, 1929; Hildebrand and Cable, 1934; Moody, 1950.) It is found in greatest numbers in the confines of semi-landlocked lagoons and quiet estuaries. It is nearly always found associated with the marine grasses *Thalassia testudinum* and *Diplanthera wrightii.*

These grasses harbor a distinctive and rich population of crustaceans, molluscs, marine worms and small fishes. Such an environment is also preferred by the black mullet, *Mugil cephalus,* and many herring-like fishes. The number of grazers, browsers and filter feeders is a conspicuous feature of the areas where the spotted weakfish are most numerous.

The second outstanding feature noted in such an environment is the scarcity of predator and competitor species both in point of numbers of species and numbers of individuals of each. The spotted weakfish appears to have successfully invaded the rich feeding grounds of the euryhaline herbivores and, under ideal conditions, rests almost alone at the top of the food chain.

The full impact of predators upon the survival of the spotted weakfish is not known but the numbers of year-round predator species diminishes rapidly as one samples farther inshore from tidal inlets into the lagoon environment. (Gunter, 1938a, 1938b)

Life within the restricted environment of brackish water bays is hazardous to animals not completely euryhaline. The spotted weakfish is sensitive to changes in temperature and to a lesser degree to salinity, so that it reacts quickly to extreme changes in its environment. Such changes may cause a mass movement of a population through inlets to the deeper and more stable temperature conditions found off-shore. In areas such as that found in the Indian River district, temperatures are apparently so favorable that movement out of the area is seldom necessary. The presence of natural and man-made channels usually provide sufficient depth and warmth to protect the species. Evidence of local movement of spotted weakfish in response to cold temperatures of winter is shown in Figure 2, which graphs sport catches in an area having deepwater refuges and an adjacent area lacking these. The Banana River is a broad, shallow lagoon comprising some 64,000 acres. Its average depth is just under four feet. The Barge Canal, cut across Merritt Island, is dredged to about nine feet in depth. The high rate of catch from the Barge Canal during the winter months opposing the low catches from the shallows of the Banana River, illustrate the use

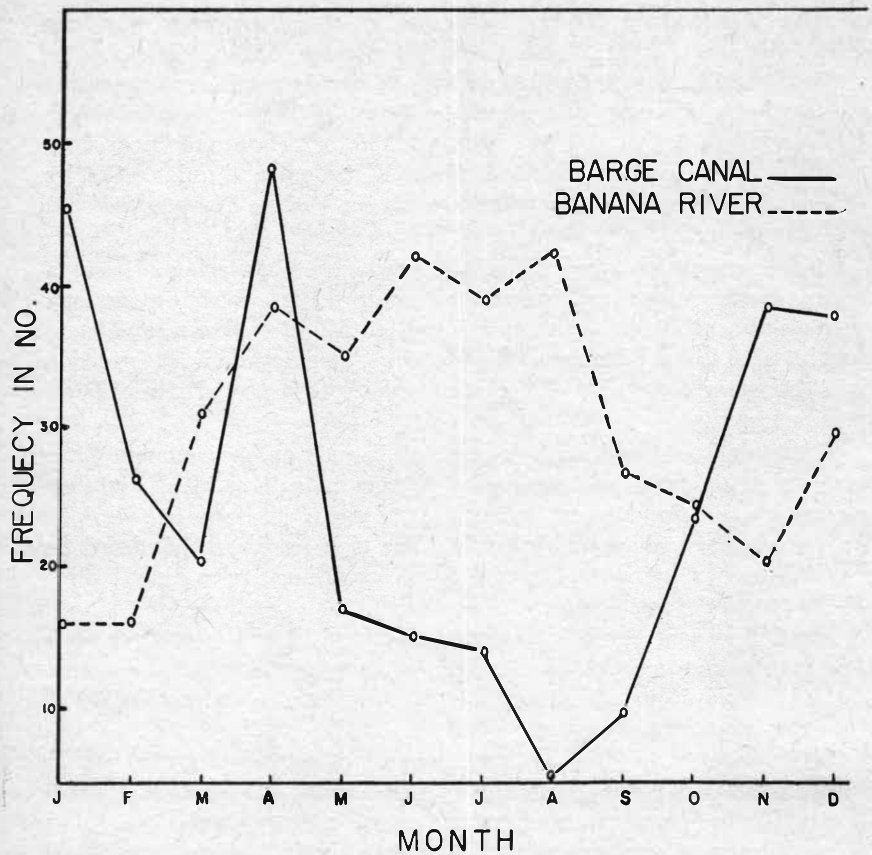

Figure 2. Graph of sample catches by month for the year 1955 from shallow and deep water areas showing seasonal movement in response to spawning and temperature fluctuations.

to which such a canal is put by the fish. As warming begins, however, there is an exodus to the rich feeding provided by the shallows, and the catches for Banana River rise sharply and continue high until the following fall. The peak shown in April on the curve for the Barge Canal probably is a result of movement of large numbers of fish through the canal just prior to the May spawning season. Catches of sexually mature fish taken at this time are found to be in advanced stages of gonadal development. Studies of spawning grounds and collections of spotted weakfish eggs, larvae and post larvae indicate that the April migration through the Barge Canal is from west to east and that in this area the Banana River is most desirable as a spawning ground.

Since temperatures exert such an influence upon yearly local distribution, it is profitable to examine the possibility that temperature might be a limiting factor in the distribution of the species throughout the state.

Commercial landing statistics are used as a measure of abundance. Examination of such data shows that on both coasts catches are greatest in the central and southern portion of the state, in the vicinity of the larger estuaries and mangrove-bordered bays. (Table 1.) Air temperatures (which are closely related to water temperatures) were recorded for the areas where growth studies have been made (Figure 3). The monthly temperatures are averages based on observations taken during a six-year period. (U. S. Department of Commerce, 1948-1954.)

The three areas used for comparison are near Cocoa, Tampa and St. Marks, Florida. The latter area is now the scene of biological investigation upon this species.

Inspection of the graph shows striking similarity between the curves

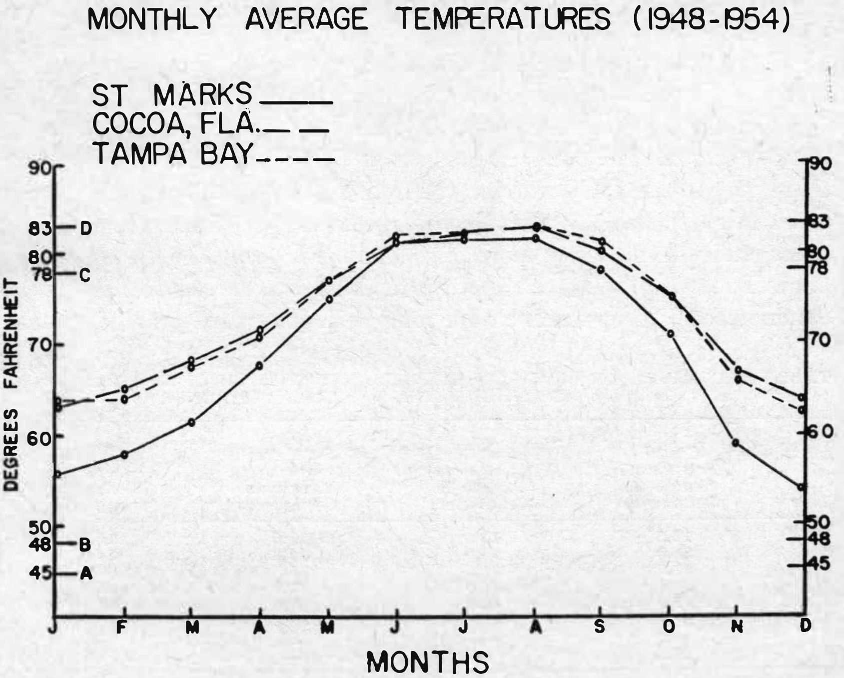

Figure 3. Graph of mean monthly air temperatures from three Florida locations which exhibit wide variations in annual commercial landings. Points A, B, C, D indicate 1.) lethal temperature; 2.) immobilizing temperature; 3.) observed water temperature at beginning of spawning season; 4.) observed water temperatures at end of spawning season.

of temperature for the Tampa and Cocoa regions, both of which produce yearly catches in excess of 300,000 pounds. St. Marks temperatures deviate markedly from the other two curves and the annual catch is less than 50,000 pounds.

In order to determine the importance of such deviation it is necessary to have information concerning the temperatures tolerated by the spotted weakfish. Observations pertaining to lower limits were made during the course of the Indian River investigations and during the cold weather during the second week of December, 1957. The critical values have been included in the graph of mean monthly air temperatures. Kills of spotted weakfish occur most often during the first hard, sudden cold of winter. (Gunter, 1941b.) This causes a sudden drop in temperature, which chills the shallows, and this is often accelerated by wind mixing. At such times the fish may be immobilized and then killed before they may effect a movement to deep water. Spotted weakfish have been observed by the writer to recover rather quickly after being immobilized by cold for short periods, but if the fish are exposed to about a 48°F. temperature for about 12 hours they may not recover. They are apparently always killed when exposed to 45°F. temperatures for 24 hours. If surviving fish have managed to move to deeper, warmer water they tend to remain there until the spring warming occurs. This largely prevents loss from more than one kill per season. The temperatures shown in Figure 2 are averages and there may be some days during the four winter months when temperatures fall dangerously low for the species in the Tampa and Cocoa areas, and usually many more days when this occurs in the St. Marks area. Because of this, the spotted weakfish are forced to live in the confinement of deep channels for long periods of time probably under

TABLE 2. COMPARISON OF CALCULATED YEARLY GROWTH OF SPOTTED WEAKFISH FROM VARIOUS AREAS WITHIN ITS RANGE

	Florida			Texas
Year	Cocoa[1] (*east coast*) Length in Centimeters	Punta Gorda[2] (*west coast*) Length in Centimeters	St. Marks[3] (*north west*) Length in Centimeters	Corpus Christi[4] Length in Centimeters
1	16.5	12.0	11.6	15.0
2	24.8	23.0	19.2	24.0
3	31.7	31.0	25.7	30.0
4	38.4	36.0	31.4	35.0
5	45.7	40.0	37.6	40.0
6	53.3	43.0	42.8	44.0
7	56.1	....	....	49.0
8	61.6	....	....	52.0

[1]Tabb, Durbin C., 1956. Unpublished.
[2]Welsh, William W., and C. M. Breder, Jr., 1924.
[3]Tabb, Durbin C., and Edward Klima, 1958. Unpublished.
[4]Pearson, John C., 1929.

conditions unfavorable for feeding. This is apart from the usual effect on metabolism of lower average temperatures.

The consequence of the differences in temperature on growth are exhibited in Table 2.

It is apparent that growth is more rapid and the fish grow to a larger size in the Tampa and Cocoa areas than near St. Marks.

Many factors other than the ones mentioned probably contribute to the abundance and "success" of the spotted weakfish. The following are believed to be of greatest importance.

1. Large areas of shallow, quiet, brackish water (bays and lagoons).
2. Absence of predators.
3. Absence of competitor species.
4. The presence of large areas of marine and brackish water grasses.
5. An abundance of grazing crustaceans and fish of suitable size to be utilized as food throughout the year.
6. A stable temperature, ranging between about 60°F. and 80°F.
7. Adequate areas adjacent to grass flats, having a depth of 10-20 feet that may be used as winter refuge from cold.

Perhaps, in addition, such hydrographic conditions as salinity, turbidity or others may have even greater influence on the species than temperature, and it is not suggested by the above analysis that the latter is necessarily the most important. No quantitative data are available on other factors, however, and it seems possible that temperature is one of the important limiting conditions for the weakfish.

A thorough understanding of the ecology of valuable species such as the spotted weakfish involves time and concentrated effort. If adequate data are to be obtained in order to assess the harm being done during future land reclamation, biological investigation must be accelerated and expanded. In the meantime those organizations charged with the responsibility of preserving our natural resources must be given authority to act upon the strength of data now available to save as intact as possible those areas which conform to the criteria of ecological desirability.

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DISCUSSION

CHAIRMAN RANEY: Those of us who have lived near New York City have seen estuaries destroyed over the years with subsequent destruction of both fin- and shellfish. Recently, the migration of millions of people to Long Island has threatened the great wetland area of southern Long Island. Bulldozers and steam shovels have come in and actually the south shore is already ruined, and there is only a little hope that by very fast action the wetlands of Great South Bay and other regions might be saved.

It comes as somewhat of a surprise to me that Florida, which I usually think of as a very wild state in many respects, has been faced by the same problem—the destruction of its estuaries, at least in some instances.

DISCUSSION LEADER FAHY: If, from the standpoint of interest, we could have a fish-of-the-year, the striped bass has certainly been the winner in the past years. But the weakfish bids fair to supplant the striped bass as the fish-of-the-year in future years' programs which are underway in Delaware, New York, Virginia, Florida, Louisiana, and Texas, to name some of them.

DR. LOUIS A. KRUMHOLZ [University of Louisville, Louisville, Kentucky]: I am interested especially in the lethal effects of cold temperatures on fishes. Have you done any work to find out just how much the temperature has to drop for the fish to be killed?

MR. TABB: We haven't done any experimental work. The observations that I have made are limited in numbers and were made during actual kills on fish. There is a little information by Dr. Gunter, as you know, about lethal temperatures, gathered in much the same manner. I doubt if there has been much laboratory experimentation to determine the actual range of lethal temperatures. However, this species may exhibit some adjustments to low temperatures. The first kill of the winter usually comes on suddenly. The temperatures drop rapidly over a period of 12 to 24 hours, and the fish that are greatly affected are those that are long distances from marine environment or deep channels where they can find refuge. We have very little information of that sort.

DR. KRUMHOLZ: The reason I bring this up is that fish kills occurred in the Bahamas when the water temperature dropped to about 60 degrees. That was as low as it got, and probably not lower than 63; but we had kills of all kinds of fishes, and the temperature stayed low for just a matter of a few hours. The same thing occurred in Florida in 1940. There were tremendous kills along the West Coast, and it killed manatees and everything. The point I would like clarification on is, what is the difference in the physiology of the spotted weakfish in Florida and up the East Coast where the species can tolerate lower temperatures? Is this a physiological thing?

MR. TABBS: That I can't answer. I am sorry.

MR. WILLIAM H. MASSMAN [Virginia Fisheries Laboratory, Gloucester Point]: I would like to add to this discussion. We consider Virginia to be about the northern limit of resident spotted weakfish and we have occasional winter kills there which I am sure occur at much colder temperatures than they do in Florida. It is interesting to note that in warmer winters, we often build up a resident population of spotted weakfish in a place called Lynn Haven Inlet, a series of shallow bays with a very small channel leading out into the bay. We have trawled this area following a winter kill and found the kill to be almost a hundred per cent as far as we could tell.

Then in the following year catches in those areas were very poor. Apparently they build up gradually over a period of years until there is another cold spell.

DR. KRUMHOLZ: Do you have any information on the dates of early kills in Virginia?

MR. MASSMAN: I can't remember offhand. We have some information, but we don't have the temperatures at the time the kills took place. These kills were not early-season kills. They occurred in late January and February.

DISCUSSION LEADER FAHY: In North Carolina, in Morehead City, we have recently had a long siege of extremely cold weather. We had 1 degree Centigrade temperature. The trout numbs did not appear to be wide spread, for we have heard of no catastrophic kill. However, there were numbs reported in local areas, and this is certainly the coldest seige we have had on the North Carolina coast in the memory of many of the old-time residents. So we are deeply concerned with what has happened, to see what losses there may have been as far as this particular in-shore population is concerned.

DISTRIBUTION OF MENHADEN IN THE GULF OF MEXICO

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The most recent review of the genus *Brevoortia Gill* was that of the late Samuel F. Hildebrand in 1948. He treated seven species in this paper, gave numerous counts and measurements, changes with growth, color descriptions, and distribution, in addition to the synonymy and history of the nomenclature. Hildebrand fixed the name *B. patronus* Goode, 1878 to the large-scaled menhaden of the Gulf of Mexico. As pointed out by Hildebrand (1948), Goode (1878) used both large-scaled and small-scaled specimens of menhaden for his description of *B. patronus* and thus one form was left without a name which Hildebrand clearly described and called *Brevoortia gunteri*. An additional character not mentioned by Hildebrand which supports the idea that Goode had both forms before him at the time of description is the striae on the operculum. In the *Diagnosis* on page 39, Goode states,

[1]Aid for collecting material was obtained from NSF G 3882.

"Operculum smooth or very delicately striated;" in the *Description,* on page 40, he says, "The length of the operculum is equal to that of the eye; the opercular striations are fine, but distinct and numerous." There is no doubt that Goode had *B. gunteri* Hildebrand, 1948 before him for the *Diagnosis* and *B. patronus* Goode, 1878 (as restricted by Hildebrand) for the *Description*. Thus, Hildebrand (1948) listed two species of menhaden for the Gulf of Mexico. The following discussion is of the two species previously known to occur in the Gulf of Mexico and of a third species, *Brevoortia smithi,* thought to occur only in the Atlantic from North Carolina to northern Florida.[2]

DISTRIBUTION

Brevoortia patronus Goode, 1878

Hildebrand (op. cit.) gave the range of *Brevoortia patronus* as "Gulf of Mexico, from Appalachicola (also reported from Tampa), Fla., to Brazos Santiago, Tex." The record for Tampa was on the basis of a report by Henshall (1894), but no specimens are available to verify this record and so I believe this locality record should be accepted with caution. The author has examined numerous specimens of *B. patronus* from Brazos Santiago, Texas (including the types) to Cedar Keys, Florida. Recently Dr. Daniel M. Cohen kindly sent to me two specimens of menhaden collected at Cedar Keys, Florida in 1947 by E. L. Pierce. The two specimens are 50.3 and 51.5 mm. in standard length and coincide in counts and measurements with *Brevoortia patronus* of the western and northern Gulf.

Brevoortia gunteri Hildebrand, 1948

Hildebrand (op. cit.) gave the range of *Brevoortia gunteri* as "Gulf of Mexico, from Grand Isle, La., to the mouth of the Rio Grande, Tex." Recently, Henry H. Hildebrand (1955) reported *B. gunteri* from the Gulf of Campeche west of Punta Morros. The author has not had an opportunity to see the Campeche specimens and so can not make a comparison of the characters at this time with those of the more northern populations.

In 1954, Dr. Caldwell reported *Brevoortia gunteri* from Way Key (Cedar Key area), Florida. He did not give a catalog number for the single specimen upon which he reported. However, there is a single specimen in the University of Florida collection obtained on 21 June 1953 (the same date given in his 1954 publication), which now bears

[2]Dr. Henry B. Bigelow has informed me by recent communication that Samuel F. Hildebrand has an addendum to his distributional notes for *Brevoortia smithi* in the forthcoming volume of "Fishes of the Western North Atlantic." Thus it is evident that Hildebrand was aware of the presence of *Brevoortia smithi* in the Gulf of Mexico long before I made my independent discovery.

TABLE 1. PROPORTIONAL MEASUREMENTS, EXPRESSED IN PER CENT OF STANDARD LENGTH, OF 14 *BREVOORTIA SMITHI* FROM THE WEST COAST OF FLORIDA (UF = UNIVERSITY OF FLORIDA COLLECTION)

	UF 692 Cedar Keys	UF 693 Cedar Keys	UF 693 Cedar Keys	UF 695 Cedar Keys	Bocilla Pass, Englewood 27 Jan. 1954	Bocilla Pass, Englewood 27 Jan. 1954	Knights Pass, Englewood 22 Jan. 1954	Gasparilla Sound, fall 1957	Gasparilla Sound, fall 1957
Total length	114.7	35.0	35.7	139.0	273.0	253.0	250.0	292.0	324.0
Standard length	85.8	27.3	27.9	103.1	207.1	195.6	188.3	221.7	242.9
Dorsal origin to snout	51.7	53.1	54.4	50.4	50.9	50.6	50.8	52.0	53.5
Dorsal origin to caudal base	54.2	52.0	54.4	54.2	53.3	53.4	55.2	55.6	55.0
Dorsal origin to occiput	29.5	29.6	26.1	29.9	31.0	31.3	31.1	32.2	33.8
Pelvic insertion to snout	54.7	55.6	54.8	53.9	53.6	54.6	53.2	54.8	53.4
Anal origin to caudal base	33.4	30.7	30.1	32.7	28.7	30.3	32.3	30.0	27.4
Body, greatest depth	40.0	37.3	38.7	41.4	38.8	38.2	38.7	40.9	40.0
Caudal peduncle, length	12.4	11.3	11.4	12.4	10.1	10.4	11.3	9.2	9.8
least depth	11.4	12.4	14.3	11.6	10.6	10.0	10.4	10.4	10.0
Head, length	31.8	33.3	32.9	31.2	29.7	29.8	29.1	30.0	30.0
depth	29.5	24.1	26.8	28.9	28.0	27.2	27.1	27.9	28.3
width	13.0	11.3	12.9	13.3	13.6	12.9	13.3	13.6	14.7
Snout length	8.3	8.0	8.6	7.9	7.9	7.7	7.9	8.3	8.6
Eye length	8.7	9.8	10.0	8.0	5.9	5.7	6.2	5.9	5.4
Upper jaw length	14.6	14.6	14.6	14.4	13.0	12.4	12.8	14.8	13.9
Mandible length	17.8	17.2	17.5	16.8	16.4	16.3	16.1	17.4	16.5
Pectoral axillary appendage	8.9	8.0	7.5	10.0	10.2	10.3	10.6	11.4	11.2
Dorsal fin, depressed length	24.9	23.0	25.0	26.1	26.1	24.3	25.1	26.8	26.3
Dorsal base	17.3	19.4	18.2	19.7	19.9	18.4	19.3	21.2	20.4
Anal fin, depressed length	25.0	22.7	23.2	25.9	23.6	23.9	25.9	25.7	21.7
Anal base	20.3	18.6	19.7	20.7	19.0	19.5	22.3	21.0	17.7
Caudal fin length, lower lobe	32.0	34.4	....	34.5	33.5	31.6	34.4	32.6	34.6
Pectoral fin length	18.4	18.6	19.3	18.0	18.1	14.7	18.0	20.0	19.8
Pelvic fin length	10.1	12.4	12.5	10.1	8.9	8.6	8.6	9.2	9.4
Distance, pectoral insertion to pelvic insertion	25.1	27.8	27.2	24.8	26.1	26.4	24.7	27.5	26.0

TABLE 1 (Continued)

	Placida 9 May 1957	Placida 9 May 1957	Placida 15 Aug. 1957	Placida 15 Aug. 1957	Placida 15 Aug. 1957	Range	Average
Total length	....	....	88.1	85.4	83.5	35.0-324.0	
Standard length	83.2	80.7	64.8	64.6	61.8	27.3-242.9	
Dorsal origin to snout	50.8	51.4	56.1	52.5	54.6	50.4- 56.1	52.3
Dorsal origin to caudal base	53.6	53.8	49.6	52.2	51.4	49.6- 55.6	53.4
Dorsal origin to occiput	27.2	28.1	32.8	30.0	31.0	26.1- 33.8	30.2
Pelvic insertion to snout	53.9	53.5	58.4	56.0	58.0	53.2- 58.4	54.8
Anal origin to caudal base	31.4	32.7	28.6	30.1	29.7	27.4- 33.4	30.5
Body, greatest depth	37.7	39.8	39.1	38.8	41.4	37.3- 41.4	39.3
Caudal peduncle, length	12.4	12.3	10.8	11.2	10.8	9.2- 12.4	11.1
least depth	11.2	12.2	11.5	11.4	12.2	10.0- 14.3	11.4
Head, length	30.8	31.0	35.7	34.0	34.3	29.1- 35.7	31.6
depth	27.8	29.4	32.8	31.8	33.4	24.1- 33.4	28.7
width	13.8	13.8	15.1	14.3	14.0	11.3- 15.1	13.5
Snout length	7.8	8.4	9.4	8.9	9.3	7.7- 9.4	8.3
Eye length	8.1	7.5	10.6	10.5	9.7	5.4- 10.6	8.0
Upper jaw length	13.4	13.1	16.3	15.1	16.1	12.4- 16.3	14.2
Mandible length	16.2	17.0	18.6	18.4	18.9	16.1- 18.9	17.2
Pectoral axillary appendage	....	....	9.1	9.7	9.8	7.5- 11.4	9.7
Dorsal fin, depressed length	24.5	25.8	24.2	24.4	25.2	23.0- 26.8	25.1
Dorsal base	....	....	18.0	17.7	18.6	17.3- 21.2	19.0
Anal fin, depressed length	23.7	24.4	23.4	23.2	23.6	21.7- 25.9	23.9
Anal base	....	....	20.0	18.8	20.0	17.7- 22.3	19.8
Caudal fin length, lower lobe	32.3	33.7	36.1	35.1	....	31.6- 36.1	33.7
Pectoral fin length	18.2	17.9	18.0	17.9	18.9	14.7- 20.0	18.2
Pelvic fin length	9.1	9.5	10.1	9.5	10.6	8.6- 12.5	9.9
Distance, pectoral insertion to pelvic insertion	24.0	25.5	25.4	25.2	25.4	24.0- 27.8	25.8

the number UF 692. I assume this specimen to be the same as that of Caldwell (1954) and identify this specimen, UF 692, as *Brevoortia smithi* (Table 1 and 3). Apparently *B. gunteri* does not extend eastward beyond the Grand Isle, Louisiana area. Certainly if *B. gunteri*[2] does occur east of Grand Isle it does not frequent the brackish water habitat noted for it in Texas waters by Gunter (1945). The above statement is based upon several years of study of Lake Ponchartrain and adjoining brackish water areas during which time many thousands of specimens were examined and all were referred to the species *B. patronus* (Suttkus, 1956). Furthermore, I have examined many specimens from Mississippi, Alabama and west Florida coasts and all prove to be *B. patronus.* The head of a menhaden from Escambia Bay, Florida reported upon by Bailey, Winn and Smith (1954) as either *B. patronus* or *B. gunteri* is definitely *B. patronus.* This positive identification is based on the presence of numerous, well-developed striae on the operculum.

Brevoortia smithi Hildebrand, 1913

Hildebrand (op. cit.) gave the range of *Brevoortia smithi* as, ''Beaufort, N. C., to the 'Indian River,' presumably Indian River City, Fla.'' My personal discovery of *B. smithi* in the Gulf of Mexico occurred in November of 1957. An examination of some fine-scaled menhaden from the Cape Haze Marine Laboratory at Placida, Florida disclosed the presence of *B. smithi* on the west coast of Florida.

DISCUSSION OF CHARACTERS

A tabulation of proportional measurements of 14 specimens is given in Table 1. The data for the specimens are arranged according to the locality i.e. most northern (Cedar Keys) on left and most southern (Placida) on the right. This arrangement was used to determine if there is a north-south cline. No cline is demonstrated in this small sample. Proportional measurements for an additional nine specimens of *B. smithi* from Placida are given in Table 2. These small specimens are thought to be representative of the transformation stage (Suttkus, 1956) and so are not comparable to the specimens treated in Table 1.

The various meristic characters were enumerated for the 23 specimens of *B. smithi* from the Gulf of Mexico and these data are given in Table 3. No north-south clines are apparent upon examination of these data. However, there is an indication of a north-south cline in the number of vertebrae when one compares the Atlantic with the Gulf of Mexico specimens (Table 4). A comparison of proportional measure-

[2]This species referred to as *Brevoortia* sp. "the brackish water menhaden of Texas" by Gunter (1945).

TABLE 2. PROPORTIONAL MEASUREMENTS, EXPRESSED IN PER CENT OF STANDARD LENGTH, OF NINE SMALL *BREVOORTIA SMITHI* FROM GASPARILLA SOUND, PLACIDA, FLORIDA

	Placida 15 May 1957									Range	Average
Total length	32.7	33.6	32.3	32.0	31.0	29.0	31.5	31.2	28.2	28.2-33.6	
Standard length	26.1	26.5	25.3	25.1	24.4	23.0	24.2	24.6	22.4	22.4-26.5	
Dorsal origin to snout	50.9	51.6	52.1	51.7	51.2	52.1	52.4	51.6	52.2	50.9-52.4	51.7
Dorsal origin to caudal base	46.3	49.0	50.1	49.4	52.0	49.5	48.7	52.4	49.5	46.3-52.4	49.6
Dorsal origin to occiput	26.0	26.0	26.0	25.8	25.8	26.5	26.0	25.6	25.4	25.4-26.5	25.9
Pelvic insertion to snout	55.5	56.9	56.5	53.7	54.9	53.9	54.5	55.6	55.3	53.7-56.9	49.2
Anal origin to caudal base	26.8	27.5	28.8	28.6	28.6	29.1	28.5	29.6	27.2	26.8-29.6	28.3
Body, greatest depth	33.3	34.7	33.9	33.4	33.6	32.1	30.9	33.7	32.5	30.9-34.7	33.1
Caudal peduncle, length	9.5	9.0	10.6	10.3	10.2	11.3	10.7	11.3	10.2	9.0-11.3	10.3
least depth	11.8	11.3	11.4	12.3	11.8	11.3	11.5	10.9	11.6	10.9-12.3	11.5
Head, length	33.7	35.0	35.1	35.4	34.4	34.7	34.7	34.5	36.1	33.7-36.1	34.8
depth	30.2	31.3	29.2	30.2	29.9	28.6	29.3	30.4	29.9	28.6-31.3	29.8
width	13.7	13.9	13.4	13.5	13.5	14.3	13.2	14.2	13.3	13.2-14.3	13.6
Snout length	7.2	8.6	7.9	7.5	7.7	8.2	8.6	8.1	7.1	7.1- 8.6	7.8
Eye length	9.1	10.9	9.4	9.9	9.8	9.1	10.3	10.1	9.8	9.1-10.9	9.8
Upper jaw length	13.4	13.5	13.0	13.1	13.1	13.0	13.6	13.4	13.3	13.0-13.6	13.2
Mandible length	16.0	16.9	16.9	16.3	16.8	16.9	16.9	17.0	16.9	16.0-17.0	16.7
Pectoral axillary appendage	7.2	4.5	5.1	5.5	4.0	4.3	4.9	5.2	4.4	4.0- 7.2	5.0
Dorsal fin, depressed length	22.9	23.7	23.7	23.9	23.7	23.0	24.3	25.6	24.9	22.9-25.6	23.9
Dorsal base	15.7	17.3	16.9	17.1	18.0	17.8	16.9	19.9	18.3	15.7-19.9	17.5
Anal fin, depressed length	19.9	19.9	22.1	20.7	20.4	21.7	21.4	22.7	19.1	19.1-22.7	20.8
Anal base	16.8	16.2	16.5	17.1	17.2	17.3	17.3	18.6	15.6	15.6-18.6	16.9
Caudal fin length, lower lobe	31.0	....	29.2	27.4	....	25.6	26.0	28.0	29.0	25.6-31.0	28.0
Pectoral fin length	18.0	18.8	17.7	19.5	18.4	18.6	18.5	19.5	19.1	17.7-19.5	18.6
Pelvic fin length	9.5	10.5	11.4	11.9	11.8	11.3	11.1	11.3	12.4	9.5-12.4	11.2
Distance, pectoral insertion to pelvic insertion	24.5	24.1	24.5	21.9	24.1	23.9	24.3	26.4	23.6	21.9-26.4	24.1

TABLE 3. MERISTIC CHARACTERS OF 23 SPECIMENS OF *BREVOORTIA SMITHI* FROM THE WEST COAST OF FLORIDA[1]

	Cedar Keys				Englewood			Gasparilla Sound	
Fin rays									
Dorsal	18	19	19	20	20	19	19	18	18
Anal	22	22	22	22	22	21	23	22	22
Pectoral	16-16	15-15	15-15	15-15	16-17	15-15	16-16	16-16	16-16
Pelvic	7-7	6-6	7-7	7-7	7-7	7-7	7-7	7-7	7-7
Scales									
Predorsal, modified	42	42	42	42	48	47	44	50	45
Transverse body rows	62	60	61	60	64	66	73	70	72
Between tip of pectoral and insertion of pelvic	7	6	5	5	7	11	6	5	7
Gill rakers, lower limb	112	52	54	115	143	137	135	140	139
Vertebrae, total	45	45	....	45	45	45	45	45	45
Ventral scutes, total	30	33	30	31	32	31	30	30	31

[1]This table contains statistics on the same specimens used for Tables 1 and 2 from left to right respectively.

	Placida									
Fin rays										
Dorsal	19	18	18	18	18	19	19	19	19	20
Anal	22	22	22	22	22	23	21	21	20	23
Pectoral	15-15	15-15	15-15	15-15	16-16	15-15	15-15	15-15	16-16	15-15
Pelvic	7-7	7-6	7-7	5-7	7-7	7-7	7-7	7-7	7-7	7-7
Scales										
Predorsal, modified	....	....	44	45	50	44	41	42	41	43
Transverse body rows	....	....	67	63	64	67	66	62	63	70
Between tip of pectoral and insertion of pelvic	....	....	7	6	6	8	7	7	5	8
Gill rakers, lower limb	....	....	109	103	100	57	59	56	54	56
Vertebrae, total	45	46	45	45	45	46	46	45	45	46
Ventral scutes, total	31	32	31	30	32	31	31	30	31	31

	Placida				Range	Average
Fin rays						
Dorsal	18	19	20	19	18-20	18.8
Anal	22	22	24	21	21-23	21.9
Pectoral	16-15	16-16	15-15	15-15	15-17	15.3
Pelvic	7-7	7-7	7-7	7-7	5-7	6.9
Scales						
Predorsal modified						
Transverse body rows	43	45	42	....		
Between tip of pectoral	69	63	66	68	60-73	65.5
and insertion of pelvic	6	7	7	6	5-11	6.6
Gill rakers, lower limb	49	51	54	51	52-143	86.9
Vertebrae, total	45	45	45	45	45 and 46	45.2
Ventral scutes, total	32	30	30	32	30-32	30.9

ments given by Hildebrand (*op. cit.*), for *B. smithi* from the Atlantic and my data for Gulf of Mexico specimens show very little difference (Table 5). The eye and snout measurements are difficult to make because of the adipose eyelid which develops with age and probably this difficulty has resulted in a certain amount of personal error. My high *caudal peduncle, least depth* (14.3) and low *pectoral fin, length* (14.7) values are correct and were checked twice. In the two specimens involved the particular measurements represent an anomalous condition in those structures only. The slight variation in the ranges of our other measurements can be attributed to the small number of specimens treated in each study and neither of us has completely described the range of variation.

As given above, *Brevoortia gunteri* and *B. smithi* are widely separated geographically, *i.e., B. gunteri* in the western Gulf and *B. smithi* in the eastern Gulf and Atlantic. Hildebrand (*op. cit.*) very adequately described the two fine-scaled species and pointed out the chief differentiating characters. Hildebrand (1948) and my counts of vertebrae and ventral scutes for *B. smithi* and *B. gunteri* are given in Table 4. On the basis of these differences plus the maxillary, mandible, and pectoral fin measurements I would not suggest that the Gulf of Mexico population of *B. smithi* be considered as intermediate between *B. smithi* of the Atlantic and *B. gunteri,* but a sub-population of *B. smithi.*

TABLE 4. TOTAL NUMBER OF VERTEBRAE AND VENTRAL SCUTES IN *BREVOORTIA SMITHI* AND *BREVOORTIA GUNTERI*

	Vertebrae						Ventral scutes						
	42	43	44	45	46	47	27	28	29	30	31	32	33
B. smithi (Atlantic)[1]				3	9	1				2	11	5	
(Gulf of Mexico)				18	4					8	9	5	1
B. gunteri	1	22	18[2]				1	15	27	4[3]			

[1]Hildebrand (1948).
[2]Hildebrand (1948) and Suttkus.
[3]Hildebrand (1948).

TABLE 5. COMPARISON OF PROPORTIONAL MEASUREMENTS, EXPRESSED IN PER CENT OF STANDARD LENGTH, OF ATLANTIC[1] AND GULF OF MEXICO SAMPLES OF *BREVOORTIA SMITHI*

	Atlantic	Gulf of Mexico
	Beaufort, North Carolina-Indian River, Florida	Cedar Keys, Florida-Placida, Florida
Number	18	**14**
Total length	120.0 — 315.0	35.0 — 324.0
Standard length	91.0 — 240.0	27.3 — 242.9
Body, greatest depth	36.0 — 43.0	37.3 — 41.4
Caudal peduncle, least depth	9.5 — 12.0	10.0 — 14.3
Head, length	29.0 — 31.5	29.1 — 35.7
depth	27.3 — 31.0	24.1 — 33.4
Snout length	6.8 — 8.0	7.7 — 9.4
Eye length	6.1 — 7.5	5.4 — 10.6
Maxillary	13.2 — 15.0	12.4 — 16.3
Mandible	16.5 — 18.5	16.1 — 18.9
Pectoral axillary appendage	8.6 — 12.0	7.5 — 11.4
Anal base	19.0 — 21.0	17.7 — 22.3
Caudal length, lower lobe	32.0 — 37.0	31.6 — 36.1
Pectoral fin length	18.5 — 21.5	14.7 — 20.0

[1]From Hildebrand (1948).

SUMMARY

This paper is a discussion of the distribution of three species of menhaden in the Gulf of Mexico. Several specimens reported in the literature were reidentified and the reported distribution patterns of the species altered accordingly. The two fine-scaled species, *Brevoortia gunteri* and *B. smithi,* occur in the western and eastern Gulf respectively. The single large-scaled form, *P. patronus,* overlaps *B. gunteri* in the western Gulf from Brazos Santiago, Texas, to Grand Isle, Louisiana, and overlaps *B. smithi* in the eastern Gulf at Cedar Keys.

It is concluded that the fine-scaled menhaden in the eastern Gulf of Mexico be considered as a sub-population of *B. Smithi* and not as intermediate between *B. smithi* of the Atlantic and *B. gunteri* of the Gulf.

ACKNOWLEDGMENTS

I am grateful to the following persons for help in collection or loan of materials: Dr. Ernest A. Lachner, United States National Museum; Dr. Henry B. Bigelow and Mrs. Myvanwy M. Dick, Museum of Comparative Zoology; Dr. James Böhlke, Academy of Natural Sciences at Philadelphia; Dr. John D. Kilby and Dr. Daniel M. Cohen, University of Florida; Dr. Eugenie Clark, Cape Haze Marine Laboratory; Dr. Gordon Gunter, Gulf Coast Marine Laboratory; Mr. Edgar L. Arnold, Fish and Wildlife Service, Galveston, Texas, and Mr. Harvey Bullis, Fish and Wildlife Service, Pascagoula, Mississippi.

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DISCUSSION

DISCUSSION LEADER FAHY: Thank you, Dr. Suttkus. In this day of crash programs and the team approach to problems, it is always refreshing to learn of a lone investigator, hampered only by lack of time and lack of funds, making a significant contribution, or at least a potentially significant contribution, to industry.

MR. SYKES: Do you have any idea of the prevalence of those other species which you mentioned in commercial catches? In talking with biologists on the menhaden investigation in Bolivia, they indicate that *Brevoortia smithi* represents a small proportion of the Atlantic Coast catch in relation to *B. patronus,* and I was wondering how it figured in the over-all take.

DR. SUTTKUS: This is an important question. At the present time, we know very little about the composition of the catch in the Gulf of Mexico. Certainly, *Brevoortia smithi* does not enter into the commercial catch.

Hildebrand noted the scarcity of specimens of menhaden from the West Coast of Florida, even from all of the Florida coast. There is a mehaden fishery in Pensacola, Florida, and this is probably based entirely on *Brevoortia patronus.*

The major center, however, is in Louisiana, and here the most important species is *B. patronus* again. This leads to the consideration of the other two species. It seems likely that there are large populations somewhere in the Gulf and, on the basis of the lack of material from the estuarian areas of the young of both *smithi* and *gunteri,* I would assume somewhere out in deeper waters; both of the fine-scale forms are more prolific.

Just a couple of weeks ago, the U. S. Fish and Wildlife Service vessel, the *Oregon,* operating off the mouth of the Mississippi River, obtained a large catch of what appears to be *Brevoortia patronus,* and this is the extent of information that is even known on the spawning of *Brevoortia patronus.* We know nothing about the where and when of spawning habits. We don't know the spawning behavior, whether the fish schools or not, or the spawning period of either of the fine-scale forms in the Gulf.

DISCUSSION LEADER FAHY: It would seem an unwise policy then to base any of the management policy for menhaden in the Gulf upon the idea that there is only one species, *patronus,* in the fishery. Apparently these other two species may have potential significance.

DR. SUTTKUS: The fishermen report different kinds of menhaden in their catches. This might be due to seasonal differences in appearance and then again, it might be that other species are involved in their catches. At the present time, there are several contracts let out by the U. S. Fish and Wildlife Service for the purpose of investigating the menhaden in the Gulf.

CHAIRMAN RANEY: I wish to take this opportunity to thank the discussion leader and the biologists who have participated in this program. When I was first approached and asked to assume this responsibility for getting a program on marine and coastal resources to be given at an inland station such as St. Louis, I felt pretty much as I felt four years ago, when we had such a program in Chicago—that it would be a waste of time. And then my better sense prevailed, and I realized that even if we had a small audience, it was an audience of quality and furthermore, that these papers would be published and we hope that the fishery science has been furthered.

TECHNICAL SESSIONS

Wednesday Morning—March 5

Chairman: ROBERT L. JONES
Regional Manager, California Department of Fish and Game, San Francisco, California

Discussion Leader: C. W. SEVERINGHAUS
Biologist, New York Conservation Department, Delmar, New York

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BIG GAME RESOURCES

PROBLEMS INVOLVED IN THE USE OF DEER PELLET GROUP COUNTS

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The interest of game managers and researchers in pellet group counts as a deer census method and indicator of range use by deer has increased in recent years. This interest has been attended by a number of problems, such as sampling intensity to be employed, size, shape and spacing of plots, etc. The writers have applied the method on mule deer ranges in Utah and Nevada from 1947 until the present and we wish to present some of our observation in this paper.

Winter and summer ranges of mule deer in many of the mountainous areas of the West are well defined, a condition making pellet group counts feasible as a census method—particularly on the winter range after snow has melted in the spring. Observations by the writers and others (Ferguson, 1955, Rogers, *et al.*, in press) have shown that pellet groups of the winter just past can be distinguished from those of prior winters because of differential weathering. Thus, if pellet groups are counted on sampling units and the number computed for the entire unit, the deer population can be determined, providing the daily defecation rate of deer and the wintering period of the herd are known.

Analysis of the results of our pellet group surveys have shown that the question of sampling adequacy, so frequently asked, is one lacking a definite answer. It is dependent upon many variables such as pellet group density, size of the area to be sampled, size, shape and distributional pattern of the sampling unit, pellet group distribution and sampling accuracy desired. A discussion of the influence of these variables upon sampling is the primary aim of this paper.

We wish to acknowledge the assistance given by Dr. Meredith Morris on some of the statistical analyses and to Dr. Odell Julander for reviewing the manuscript.

METHODS OF STUDY

Pellet group counts have been made by the writers on various winter deer range units in Utah and eastern Nevada primarily to obtain a census. For the most part, systematic sampling was employed. Parallel transects were run diagonally across the breadth of the winter range from the lower to the upper edges. The first was randomly located but the others were systematically spaced at intervals of one-half to one mile, depending on the particular survey. Counts were made within circular plots systematically spaced at one- to four-chain (1 chain = 66 feet) intervals along the transects. On a few surveys, partial or full randomization of the sampling units was effected. One strip plot survey was made for a comparison with circular plots and some intensive surveys were made on small range units such as in the experimental deer pastures at Little Hills in Colorado (Rogers, *et al.*, in press).

To test for efficiency in plot size, counts were made on two and sometimes three sizes of concentric circular plots. Plot sizes tested were 0.00065-acre (3.0′ radius—supplanted later by the 0.001-acre plot—3.72′ radius), 100-square-foot (5.64′ radius and 0.0023-acre) and 0.01-acre (11.78′ radius).

SAMPLING INTENSITY AND PELLET GROUP DENSITY

Other factors being equal, sampling intensity varies inversely with pellet group density. Some surveys for Pastures 4 and 6 at Little Hills illustrate the point. Sampling percentages required (10 per cent sampling error and 70 per cent confidence limits) for Pasture

4 in 1953, 1954 and 1955 were 3.54, 1.00 and 0.65 with respective pellet group densities of 109, 324 and 538 groups per acre. Similarly, 2.14 per cent sampling in Pasture 6 was necessary in 1953 with 92 pellet groups per acre compared to 0.67 per cent in 1954 when there were 346 groups per acre.

SAMPLING INTENSITY AND AREA OF RANGE UNIT TO BE SAMPLED

Some surveys will serve to illustrate the inverse relationship between per cent of an area which must be sampled for desired confidence limits and area of the range unit being sampled (Fig. 1). Pellet group densities for the different areas were fairly uniform, ranging from 350 to 550 groups per acre.

SAMPLING INTENSITY AND SIZE, SHAPE AND DISTRIBUTION OF SAMPLING UNIT

Plot Shape:

Most deer pellet group sampling is done either on circular or strip plots of various sizes (Berner, 1955; Bennett, *et al.*, 1940; McCain, 1948; Eberhardt and Van Etten, 1956; and others). Each type of plot has certain advantages but we favor the circular plot. Ordinarily, less sampling is required when circular plots, 0.01-acre or less in size, are used than when strip plots, six feet or greater in width, are used. Also, counts on circular plots can be made by one individual, whereas

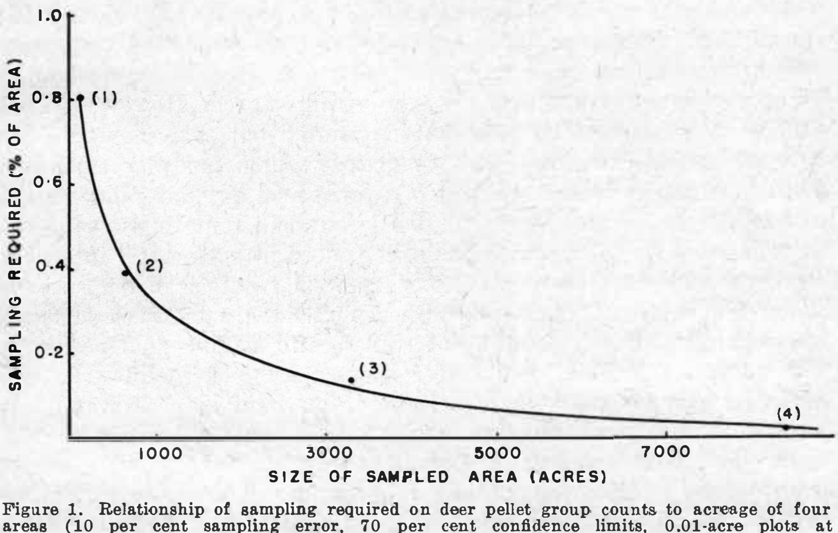

Figure 1. Relationship of sampling required on deer pellet group counts to acreage of four areas (10 per cent sampling error, 70 per cent confidence limits, 0.01-acre plots at 4-chain intervals, pellet group density—high with 353 to 527 groups/acre) (1)—Pasture 6—Little Hills; (2)—Square Mile—Oak Creek; (3)—N. Oak Creek; (4)—Ephraim.

at least two are necessary on strip plots unless accuracy is sacrificed, *i.e.*, strip lengths are paced rather than chained.

We tested the relative efficiency of circular and strip plots on a square mile of winter deer range in central Utah and found, on this particular survey, that circular plots were substantially more efficient. Stratified random sampling was employed, two randomly located transects being run within each 0.1-mile-wide belt in the area. Each circular-plot transect consisted of twenty 0.01-acre plots spaced at 4-chain intervals while each of the 20 strip transects was 6 feet wide and 22 chains in length. Thus, the area contained within the samples of each survey was identical—0.2-acre in each transect and a total of 4.0 acres for the 20 transects.

The variance of pellet group counts among transects for each of the two surveys was such that the formula for determining number of transects necessary for varying confidence limits and sampling errors indicated that only 12 transects of circular plots were necessary for a 10 per cent sampling error and 70 per cent confidence limits compared to 23 for the strips. Interestingly enough, total pellet groups counted on the four acres of each survey were almost identical—1,422 on the circular plot survey and 1,448 on the strip plot survey. In theory, the more widely dispersed the sampling units, the better the survey. In the foregoing, the circular plots were more widely dispersed than the strip plots.

A number of workers, Clapham, 1932; Pechanec and Stewart, 1940; Hasel, 1938; Bormann, 1953; and others) have concluded that long, narrow plots are superior sampling units to shorter, wider ones or to squares of equal area. With this, the writers agree. However, Hasel (1938—quoted from Bormann, *ibid.*) pointed out that segments can be systematically omitted without greatly impairing plot efficiency. This, in effect, is what a transect of equi-spaced circular plots accomplishes. Pechanec and Stewart (1940) found in sampling vegetation, that line-plot sampling, with subunits spaced at systematic intervals, was more efficient than rectangles or squares. Analysis of our surveys shows that elimination of every other plot along a transect demands somewhat less than a doubling of transects to attain equal accuracy. The values of Table 1 will better illustrate this principle. In this analysis, the variance was determined for counts on 10 randomly located transects where counts were made on 0.001-acre and 100-square-foot circular plots at 1-chain intervals. Subsequently, pellet groups were totalled for only the odd-numbered plots (or at 2-chain intervals) and then for every 4th, 8th and 16th plot along the transects. From the resulting variances, the probable number of transects

TABLE 1. NUMBER OF TRANSECTS AND PER CENT OF THE 2900-ACRE DRY CREEK AREA OF CENTRAL UTAH WHICH MUST BE SAMPLED TO EXPECT A SAMPLING ERROR OF 10 PER CENT AT 70 PER CENT CONFIDENCE LIMITS FOR TWO SIZES OF CIRCULAR PLOTS AT VARIOUS SPACINGS.

Plot Interval (Chains)	Size of Circular Plots	No. Transects Necessary	Per cent of Area Sampled
1	0.001-acre	6.0	0.040
	100 square feet	5.6	0.086
2	0.001-acre	8.9	0.030
	100 square feet	8.1	0.052
4	0.001-acre	11.8	0.020
	100 square feet	9.8	0.038
8	0.001-acre	15.5	0.013
	100 square feet	10.2	0.020
16	0.001-acre	77.3	0.033
	100 square feet	47.8	0.047

necessary for a 10 per cent sampling error and 70 per cent confidence limits was determined. The total area of the required number of plots was computed and the per cent this represented to the total area determined. A few principles emerge from the values in this table. The percentage of the whole area which must be sampled declined until a plot interval of somewhere near 8 chains was reached. In this particular survey, a plot spacing of 8 chains along each of 10 or 15 transects approaches a grid pattern because the area is about 140 chains wide. When the transects become closer together than the plot spacing along the transect, the percentage of the area which must be sampled increases as exemplified by the 16-chain plot spacing.

Data in the table also indicate, strictly from the standpoint of percentage of an area which must be sampled, the smaller the plot, the more efficient it is because greater dispersion is possible. Narrowing a strip plot increases dispersion of the sampling effort and probably efficiency, but the problem of additional manpower required over that of circular plot surveys still remains.

If the length of strip plots is determined by pacing, an error is introduced in the final computations directly proportional to any error registered in pacing. This might be appreciable in steep, rough terrain. On the other hand, if length of strip is accurately determined with a surveyor's tape and Abney level, a doubling of required manpower results. Also, if the pellet counter does not follow a stretched tape, or some other equally well defined center line, bias can develop in recording marginal groups.

Circular-plot surveys can be conducted by one person because distances between plots need not be accurately measured, providing, of course, the area of the range unit is determinable from a map or aerial photographs and is not contingent upon field mapping survey. Sampling units on a circular-plot survey are accurately delineated through use of a wire attached by a swivel to a peg at the plot center. Indications are that some pellet groups are missed in a single count. This source of error can be minimized by making two counts, one clockwise, the other counter-clockwise, on each circular plot. Viewing the ground and shadows at different angles, results many times in additional groups being seen. Double counts on strip plots are less feasible because they often lack a specific retraceable outline unless a stretched tape is followed. Also, a 0.01-acre or smaller circular plot is small enough to enable the counter to identify groups on the second count that were missed on the first. Strip plot counts must either be made by short segments, if one is to remember on the second count whether specific groups were counted or missed on the first count, or else each group must be marked such as Berner (1955) has done, for example, with paint sprayed from a pressurized can. Marking can be time consuming, however, especially in areas of high pellet group density. Offsetting this disadvantage, however, is the opportunity one has of checking on the counts of another observer.

Size of Sampling Unit:

There are at least two important considerations determining the optimum size of the sampling unit—one is minimization of personal bias and the other is efficiency in sampling.

Early in our studies we found that recorded pellet group density was almost always greater on the smaller of concentric circular plots. This condition, we believed, had two possible sources: (1) pellet groups were probably missed to an increased degree with distance from the plot center and (2) possible bias in the location of plot centers. Should plot centers fall, for example, more frequently in the openings than chance occurrence would dictate, higher pellet group densities would likely result on the smaller plots because deer defecate in the openings. When plot centers fall in small openings, a greater proportion of small plots is comprised of openings than in the larger plots.

Solution of the problem was facilitated through analyses of pellet group counts on permanent as well as temporary plots. Permanent plots were located with little or no personal bias involved. Pegs were placed at 4-chain intervals along compass lines at locations dictated by the rear chainman. It was he who meted out the tape the proper distance and waved the head chainman in line before giving the order to "stick." Temporary plots were established by pacing and the possibility for bias in their location was believed to be much greater.

Analyses of the counts showed that, although there was a greater density of pellet groups on the small plots than the large ones, the spread was considerably less on the permanent plots (Table 2). However, a difference remained even on the permanent plots, convincing us that groups were being missed.

As a consequence, two counts, clockwise and counterclockwise, were made on each plot. Three to four per cent more groups were counted in the second count than on the first but pellet group density remained greater on the small plots. An added refinement was consequently invoked. Two counts (clockwise and counterwise) were still made of each plot but accomplished in two bands—the two smaller plots (0.001-acre and 100-square-foot) in one and the remainder of the 0.01-acre plot in another. Thus, instead of attempting to cover a radius of almost 12 feet in each trip around the plot, the area was broken down into two bands of about six feet each. Results showed an excellent agreement in pellet group density for the large and small plots and although a small difference still remained between the permanent and temporary plots (Table 2) it was not significant at the five per cent level. Probably even narrower bands should be employed in areas supporting a denser ground cover than a sagebrush-juniper-bitterbrush type.

The writers were constantly aware of the influence of plot location upon pellet count results—especially during the latter part of the study—and, perhaps, for this reason an acceptably small difference was obtained in pellet group density for the 100-square-foot and the 0.01-acre temporary plots. A special endeavor was made to eliminate bias in this regard by deciding beforehand how many paces would be

TABLE 2. COMPARISON OF DEER PELLET GROUP COUNTS FOR DIFFERENT PLOT SIZES AND COUNTING METHODS

	Groups Counted on Paced Plots				Groups Counted on Permanent Plots			
	Plot Size				Plot Size			
	100	0.01-acre[1]			100	0.01-acre[1]		
Sampling Conditions	Square Feet	Actual	Expected	Per Cent Difference	Square Feet	Actual	Expected	Per Cent Difference
Once around (1 band)	4,664	18,159	20,316	−10.6	1,549	6,367	6,747	−5.6
Twice around (1 band)								
1st count	507	1,997	2,208	− 9.6	989	4,040	4,308	−6.2
2nd count	515	2,089	2,243	− 6.9	1,022	4,200	4,452	−5.7
(2 bands)								
1s count	544	2,341	2,370	− 1.2	866	3,811	3,772	+1.0
2nd count	556	2,393	2,422	− 1.2	877	3,889	3,820	+1.8
	Plot Size				Plot Size			
	0.001-acre	100 Square Feet			0.001-acre	100 Square Feet		
Twice around								
1st count	985	2,196	2,262	− 2.9	475	1,116	1,091	+2.3
2nd count	997	2,228	2,289	− 2.7	481	1,135	1,104	+2.7

[1]Number of pellet groups counted on the larger plots is given in the "Actual" column. Figures in "Expected" column were derived by multiplying the number of groups listed in the smaller plot column times the area factor between small and large plots . Thus, 100-square-foot plot values were multiplied by 4.356 to derive the 0.01-acre "Expected" values and 0.001-acre values multiplied by 2.296 to derive "Expected" 100 square foot values. Per cent differences were obtained by dividing differences between "Actual" and "Expected" values by "Expected."

taken to the next plot (determined through an ocular appraisal of the terrain) and by placing the plot as precisely on line as possible. One can maintain transect direction with fair accuracy by lining up two or more objects as a foresight. However, a compass should be carried and used when needed. When necessary to go around ledges, juniper trees, etc., square offsets should be made so the observer can accurately return to his original line of travel.

We believe that a density difference of two per cent or less for the 100-square-foot and 0.01-acre plots indicates that few groups were missed when two counts in 6-foot bands were made. This reasoning is based on the fact that small plots receive better coverage because of the "visual overlap" toward the plot center.

Data for the 0.001-acre and 100-square-foot plot comparison would indicate that bias in temporary plot location was not so great but that 0.001-acre plots could be used in sampling. While this appears true, we strongly recommend a larger plot where junipers and brush are common. The 100-square-foot plot is a good compromise toward minimizing the two sources of bias just discussed.

Distributional Pattern of Sampling Unit:

Data from a number of pellet group surveys were analyzed in much the same manner as was done with the square mile data when the relative efficiency of strip and circular plots was examined. The number of transects necessary for 10 per cent error and 70 per cent confidence limits for different plot sizes and spacings was computed. The number of man hours required for each set of conditions was then derived. One minute was allowed for pellet group counting per 100 square feet of plot and two miles per hour was allowed for all foot travel. The amount of dead travel for each survey varied, according to prevailing conditions, from about 10 to 40 per cent of the transect lengths. After these calculations, the most efficient survey, from the standpoint of time, for each plot size was selected, and data on plot and transect spacing, per cent of the area sampled and man hours necessary to complete the survey were entered in Table 3.

This table indicates that the 100-square-foot plot is essentially as efficient as the smaller 0.00065-acre and milacre plots and more so than the 0.01-acre.

It was pointed out earlier that the most efficient spacing of plots, from the standpoint of percentage of an area that must be sampled, is probably a grid pattern. However, the most efficient from the standpoint of the expenditure of time is one having a closer spacing of plots along the transect than between transects. This observation may not always be true for 0.01-acre or larger plots, or when there is a sparse density of pellet groups.

Sampling results indicate that 100-square-foot plots spaced 4 to 12 chains apart on transects about 20 chains apart could be expected to yield results with a 10 per cent sampling error and 70 per cent confidence limits. Our areas ranged from 2,900 to 7,300 acres and pellet groups from 300 to 600 per acre. Surveys conducted under conditions differing greatly from ours would likely indicate a different sampling intensity and pattern. However, the plot and transect spacing mentioned above could be tried and subsequent surveys modified, depending on what statistical analyses of the data showed.

SAMPLING INTENSITY AND ACCURACY DESIRED

Accuracy desired on a survey is a matter to be determined by the administrator or technician and it will depend largely upon manpower available, economics, time, importance of the particular survey, etc. Except under unusual circumstances, it is doubtful that one should attempt for accuracy exceeding a 10 per cent sampling error and 70 per cent confidence limits. Even this accuracy will likely be out of reason on areas having fewer than 100 pellet groups per acre.

COUNTING OF STREWN-OUT GROUPS

The majority of deer defecations appear as a single group of pellets but oftentimes they are strewn-out. The proportion of these groups will vary but on three 1-acre areas, 1,485 groups were tallied of which about eight per cent fell in this category. Normally, a group is counted if more than half falls within the plot, but this procedure

TABLE 3. MOST EFFICIENT PLOT AND TRANSECT SPACING FROM STANDPOINT OF TIME TO ATTAIN 10 PER CENT SAMPLING ERROR AND 70 PER CENT CONFIDENCE LIMITS FOR SEVERAL DEER PELLET GROUP SURVEYS.

Area	Plot Size	No. Transects Required	Most Efficient Spacing of Transects (Chains)	Most Efficient Spacing of Plots Along Transects	Per Cent of Area Sampled	Man Hours Necessary for Survey
North Oak Creek, 1953	0.00065-acre	6	30	4	0.006	9.4
	100 square feet	4	45	4	0.012	8.0
	0.01-acre	7	26	16	0.026	15.0
North Oak Creek, 1954	0.001-acre	22	13	4	0.023	33.2
	100 square feet	13	22	4	0.033	25.2
	0.01-acre	25	17	16	0.066	47.1
Dry Creek	0.001-acre	6	23	1	0.040	19.3
	100 square feet	10	14	8	0.020	22.0
Oak Creek	0.001-acre	14	30	2	0.019	35.6
	100 square feet	15	28	12	0.008	31.4
	0.01-acre	17	24	32	0.015	38.1
Berry Creek-Timber Creek	0.00065-acre	1	138	4	0.001	4.5
	100 square feet	3	60	12	0.003	9.1

will introduce some error if applied to strewn-out groups. Mean length for 185 strewn-out groups measured by us was 14.5 feet. Thus it can be seen that a 0.001-acre circular plot with a diameter of about 7.5 feet could barely contain half of a strewn-out group of average length. Longer strewn-out groups or groups failing to cross the middle of the plot would never be recorded if only those which were over half in were considered. We have recorded the proportion of strewn-out groups which fell within the different size plots in order to determine the error which might result if only those groups which were over half in were counted. Thus, on the basis of one set of data, the error for 0.001-acre plots would have been 4.1 per cent fewer groups than actual, had strewn-out groups of 0.5 groups or less been ignored; for 100-square-foot plots it would have been 2.1 per cent; and for 0.01-acre plots—0.6 per cent, or roughly inversely proportional to the relative areas of the plots. Careful field work would, therefore, dictate that fractional parts of strewn-out groups be recorded even though the error can be greatly minimized by use of large plots. This applies to circular and strip plots alike. A strewn-out group of 14.5 feet in crossing a 6-foot-wide strip at an angle between 54 and 90 degrees would likewise not be counted if groups one-half or less within were not tallied.

An alternative method would be to count a strewn-out group only if its midpoint fell within the plot.

PELLET GROUP COUNTS AS INDICATORS OF TREND IN HERD NUMBERS

An analysis of pellet group counts in the Oak Creek area indicates that a much smaller sample would suffice to indicate trend in herd numbers than is necessary for a census. Counts have been made on 336 0.01-acre permanently marked plots distributed along 7 transects at 4-chain intervals for 9 consecutive years (1949-57 inclusive). The transects are parallel and 60 chains apart.

To determine the value of a single transect as an indicator of herd trend, we first computed the per cent of the total number of groups counted each year which were found on the plots of each transect. The variance of the percentages for each transect was thus determined for the nine-year period. Variability in the number of pellet groups due to amount of time spent on the winter range by the herd from one year to another is eliminated by reducing the pellet groups found on each transect to a percentage of the whole. It is, therefore, obvious that if pellet counts are to be used as indicators of herd trend, annual corrections must be applied to them to standardize for time spent by the herd on the winter range.

TABLE 4. SUMMARY OF STATISTICAL ANALYSES OF DEER PELLET GROUP COUNTS FOR 9-YEAR PERIOD, 1949-1957, ON 7 TRANSECTS CONSISTING OF 336 PERMANENT 0.01-ACRE CIRCULAR PLOTS, OAK CREEK AREA OF CENTRAL UTAH

	Transect Number							
	1	2	3	4	5	6	7	Total
Total Pellet Groups	649	1,582	1,368	1,565	2,738	2,330	1,105	11,337
Annual Average	72	176	152	174	304	259	123	1,260
Mean Annual Per Cent of Total[1]	5.8	14.0	12.0	14.2	23.7	20.6	9.7	100.0
$S_{\bar{x}}$ of annual per cents	.667	1.100	0.567	0.901	1.090	1.060	0.625	
$S_{\bar{x}}$ as per cent of mean per cent (Sampling error)								
(70 per cent confidence level)	12.7	8.8	5.2	7.0	5.1	5.6	7.1	
(95 per cent confidence level)	26.5	18.2	10.8	14.5	10.6	11.8	14.8	

[1]The per cent which pellet groups on each transect made up of the total was determined for each of the nine years. The "Mean annual per cent of the total" is a mathematical rather than a weighted mean of nine different percentages.

An analysis of the Oak Creek records (Table 4) shows that Transects 2-7 gave trend percentages for the nine-year period with standard errors of 8.8 per cent or less of the mean at the 70 per cent confidence level. Transect 1 failed to comply with the desired 10 per cent or less sampling error but the reason is apparent when the small sample (72 pellet groups) is noted. Increased variability can be expected as sample size diminishes. A linear regression of our data indicates that about 124 groups or more are necessary per transect to expect a sampling error of 10 per cent or less at 70 per cent confidence limits. It should be emphasized that on this study annual pellet counts were made on the same plots. Greater variability could be expected in results if plot locations were not precisely the same from year to year. Also, our results are not to be construed as meaning that one transect with 124 or more groups accurately reflects the true yearly herd trend within 10 per cent 3 out of 10 times (assuming an accurate correction for the relative period of time spent by the herd on the winter range). Rather, it means that the single transect attains this accuracy relative to the trend indicated by all 7 transects on which an average of 1,260 pellet groups were counted annually. Analyses of the 1957 records indicated a 15 per cent sampling error at 70 per cent confidence limits could be expected in estimating total pellet groups from counts on the seven transects.

This study indicates that the game manager can probably be adequately appraised of deer numbers by first making an intensive pellet group survey to establish herd numbers and by determining trends in subsequent years through use of a much smaller sample—possibly no more than 10 per cent of the initial survey.

DETERMINING TIME SPENT BY HERD ON WINTER RANGE

Total days spent by a deer herd on the winter range must be ap-

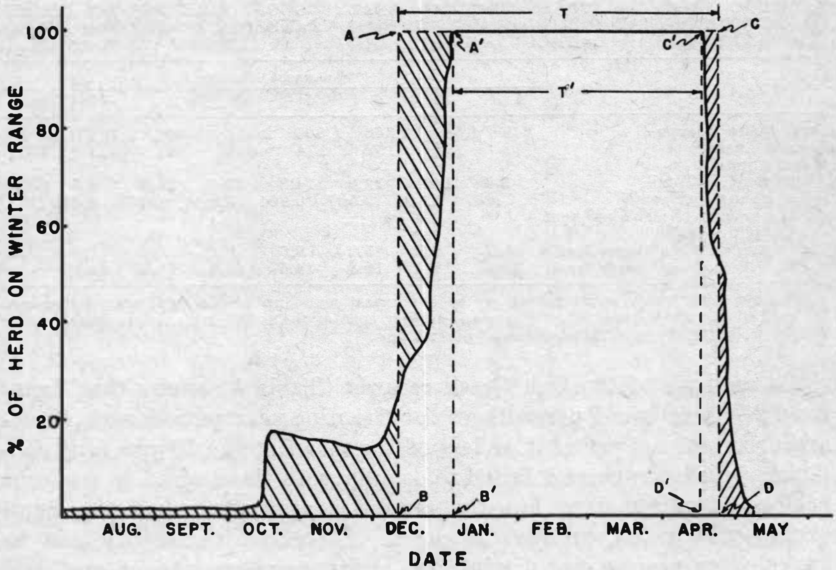

Figure 2. Chart from which deer herd days spent on winter range is determinable (see text).

proximated before herd numbers can be computed from pellet counts. Owing to irregular herd movements this is not usually determinable from the interval when half of the herd has moved onto the winter range in the fall until half have left in the spring.

In Utah it is not uncommon for some deer—possibly two or three per cent of the herd—to remain on the winter range throughout the summer. During the October hunt as many as a fourth or a third of the herd may be driven from the summer to the winter range, providing it offers favorable escape cover. Some may return to the summer range with cessation of hunting. Subsequent storms push varying proportions of the remaining deer down onto the winter range. It is, therefore, necessary that periodic appraisals be made of the proportion of the herd on the winter range and this information graphed before the number of herd days can be estimated (Fig. 2). From these appraisals a curve can be drawn (heavy line in Fig. 2). The period can be closely approximated by drawing two perpendicular lines, AB an CD in Fig. 2, in such a manner that the crosshatched areas on either side of each line are equal. The interval on the x-axis subtended by lines AB and CD represents the mean number of days (or herd-days equivalent) spent by the herd on the winter range. Greater precision can be attained in computing the interval through use of the following formula:

T:T′ = Area (ABCD) : Area (A′B′C′D′) where:

T = Mean number of days spent by herd on winter range or herd-days equivalent

T′ = Period of time when entire herd was on winter range

Area (ABCD) is determinable by planimetering entire area under curve.

Area (A′B′C′D′) is derived from the rectangle formed by dropping two perpendiculars, A′B′ and C′D′, to the x-axis from the two points when 100 per cent of the herd first reaches the winter range in the fall and when the first deer leave in the spring.

Absolute precision cannot be attained in the periodic appraisals of the percentage of deer on the winter range. However, small errors in this regard are probably not serious because an over- or under-estimate of a week, for example, in a 140-day winter period (about average for Utah conditions) would represent an error of only about 5 per cent in estimating herd numbers. Errors in the spring estimates can be minimized if pellet group counts can be made before the herd leaves.

SUGGESTIONS FOR MAKING PELLET GROUP COUNTS

Pellet group counts should be made as soon as snow disappears from the winter range. The advantages are many:

(1) Error in estimating the number of herd days spent on the winter range can be reduced if counts are made before the herd's departure.

(2) Possibility of missing groups is minimized by making counts prior to new growth of grasses and forbs.

(3) There is less difficulty in distinguishing current winter's groups from older groups at this time than later. Observations have shown that in the semi-arid regions most of the change in appearance of pellet groups occurs during late spring and summer (Ferguson, 1955).

(4) The influence of dung beetles upon counts is minimized. In the Oak Creek area, 100 pellet groups were marked on March 27, 1956, prior to beetle activity. By late May when beetle activity had subsided, 14 per cent of the groups had been completely buried and an additional 7 per cent would, perhaps, not have been recognized as groups, for only 1-10 pellets remaining in each. Fifty-seven per cent of the groups showed at least some beetle disturbance. Similar ob-

servations in 1954 within the same area showed complete loss of 7 per cent and some disturbance in an additional 19 per cent. Dung beetle populations differ widely even in areas only a few miles apart but in areas where beetles are common, pellet group counts should be made before they become active.

Counts should never be made when pellets are wet. Current and older groups are oftentimes indistinguishable when wet and observations at Little Hills in Colorado have shown that groups may persist for five or more years.

If varying densities of deer prevail on a large unit of winter range, it may be profitable to subdivide or stratify the area for sampling purposes. As pointed out in this paper, areas with a high pellet group density normally require less sampling than areas with a sparse density. We recommend that transects traverse the winter range in the direction of greatest variability. In our areas, this means diagonally across the foothill drainages from the lower to the upper edges of the winter range. This reduces variability of results among transects and, consequently, the amount of sampling required. It is desirable to analyze the data statistically on a transect basis rather than by individual plots for two reasons. It eliminates the skewed frequency distribution so common with 100-square-foot circular plot data and randomization of transects is easier than with individual plots. If transects differ considerably in length, a weighting process is necessary if results are statistically analyzed.

We suggest the use of 100-square-foot circular plots spaced systematically on a trial basis at 4- to 12-chain intervals along parallel randomized transects averaging 20 chains apart. Subsequent sampling can be modified as dictated by statistical analyses of results.

SUMMARY

Our studies have shown that increased sampling of deer pellet groups is necessary with a decrease in size of area of unit being sampled, with a decrease in pellet group density and in decreased uniformity of pellet group distribution.

Circular plots were found to be more efficient sampling units than strip plots. The 100-square-foot circular plot was found to be more efficient than the 0.01-acre circular plot where pellet group densities of 300 or more per acre prevailed. We advise against the use of plots smaller than 100 square feet because of the possible influence which bias in plot location might have upon results.

Our surveys indicated the optimum spacing (considering time and accuracy) of transects to be about 20 chains with 100-square-foot

circular plots spaced from about 4 to 12 chains apart along the transects. Optimum transect and plot spacing, however, will vary considerably from one survey to another.

Much less sampling is required to establish deer herd trends than for a census, a factor which may prove of value to administrators faced with limited budgets.

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DISCUSSION

MR. DONALD R. THOMPSON [Wisconsin]: I would like to comment on the fact that you can get by with lower samplings on the higher density areas. Of course, for a particular level of accuracy this is essentially true. However, there is something else that you have to remember—that you are after total population rather than simply approximating the population in connection with a given accuracy level. Therefore, you would want your sample a bit heavier, the idea being that more accuracy has that much more of an effect on your final outcome. It depends, of course, on what you are after. In Wisconsin we are trying to get total deer usage, and so we try to avoid total deer population on particular units of so many acres.

I am also interested in this dropping down to seventy per cent confidence levels in connection with accuracy limits. I think that in wildlife work that could be done more often. Statisticians use a 95 to 99 per cent level, but in the crude management techniques that we have available and that our legislatures give us, that 70 per cent would be adequate.

MR. ROBINETTE: Of course, I agree with that.

ESTIMATING THE EFFECTS OF EXPLOITATION BY LIFE TABLES

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Operational policy in game management has emphasized habitat control during the past two decades while notably less effort has been expended on direct population management. The restoration program has aimed to develop more habitat for expanding animal populations while the mechanics of controlling animal numbers directly have nearly been neglected. Population management is readily identified with herd management in the livestock industry; both employ at least a rudimentary knowledge of population dynamics.

While an efficient population management program should be founded primarily on a census coupled with kill control, in the absence of known population parameters, actuarial (life table) methods provide a means of calculating the more important functions of population dynamics. In the past ten years biologists have employed similar methods for estimating survival and mortality and in attempts to identify their significance.

Life table methodology is a process of inductive reasoning that is mechanically and logically simple. It also has the advantage of requiring only a few assumptions regarding sampling procedure and interpretation. Nevertheless, the procedure is not a substitute for an enumerative census although actuarial methods do provide a refined method for calculating vital statistics which a purely enumerative census can not directly reveal.

The objective herewith is to explore the possibility of gaining manipulative control of game populations by means of the knowledge of population mechanics that can be described by life table methods. Life tables for wild populations have been prepared by Banfield (1955), Deevey (1947), Hickey (1953), Paynter (1947) and probably some others. The methods are adequately described by Pearl (1940) and in many other works concerned with human population dynamics.

Efforts to describe the structures of game populations have also been published by Bellrose and Chase (1950), by Hayne (1953), and in an unpublished paper by Buechner, *et al* (1953). In all of these works emphasis was placed on measuring mortality and survival, although Banfield, Deevey and Paynter calculated other vital statistics such as mean expectation of life and longevity. The bulk of these analyses were based on hunters' kill records and therefore might be suspected of being selective, that is, non-random.

The basis of the present paper is a unique record of a once-living roe deer population that was obtained from a controlled hunt in Denmark. This resulted in the complete extermination of the stock (Andersen, 1953). Andersen has published a list of the animals killed, individual by individual. As described by Andersen "the deer were shot irrespective of age and sex—this is important for what follows." This time-specific mortality record provides a basis for developing some hypotheses of exploitation and for revealing how our conception of vital statistics is dependent on level of exploitation. The unique quality of this array of data is that the entire population was ultimately killed and thus provides a description of the entire living herd to which the effects of hunting can be compared step by step.

METHODS

Andersen's kill record of 213 deer was arranged in respective age classes and a life table prepared by conventional methods (Table 1) to describe the structure of the once-living herd. While the d column represents the number of animals killed in each age class, these same animals were alive as a herd or population at the beginning of the experimental hunt. The same procedure was applied to the groups of data that represent a kill of 25 per cent of the herd, 50 per cent of the herd, and 75 per cent of the herd. Resulting calculations are presented in the tables that follow.

As it is beyond the scope of this paper to describe in detail all of the changes in vital statistics that would be effected by the differences in the data at the different levels of exploitation, the life tables are abridged to the extent that mortality rates, life expectancy rates, etc., are not calculated. However, it is implicit in what follows that a quantitative concept of these particular vital statistics as they might be calculated from the different levels of sampling would vary as do the mortality and survival data that are discussed in this study. This is important if any realistic and useful knowledge is to be gained about populations but if the point is made by discussing only survival and mortality it is unnecessary to illustrate further.

Whereas Andersen chose to describe the changes in the proportions of young to adult and males to females in the herd at arbitrary intervals of time during the process of extermination, the present paper presents these data by a different method of analysis and describes the changes of herd composition by specific age classes as well as sex, at three different levels of exploitation.

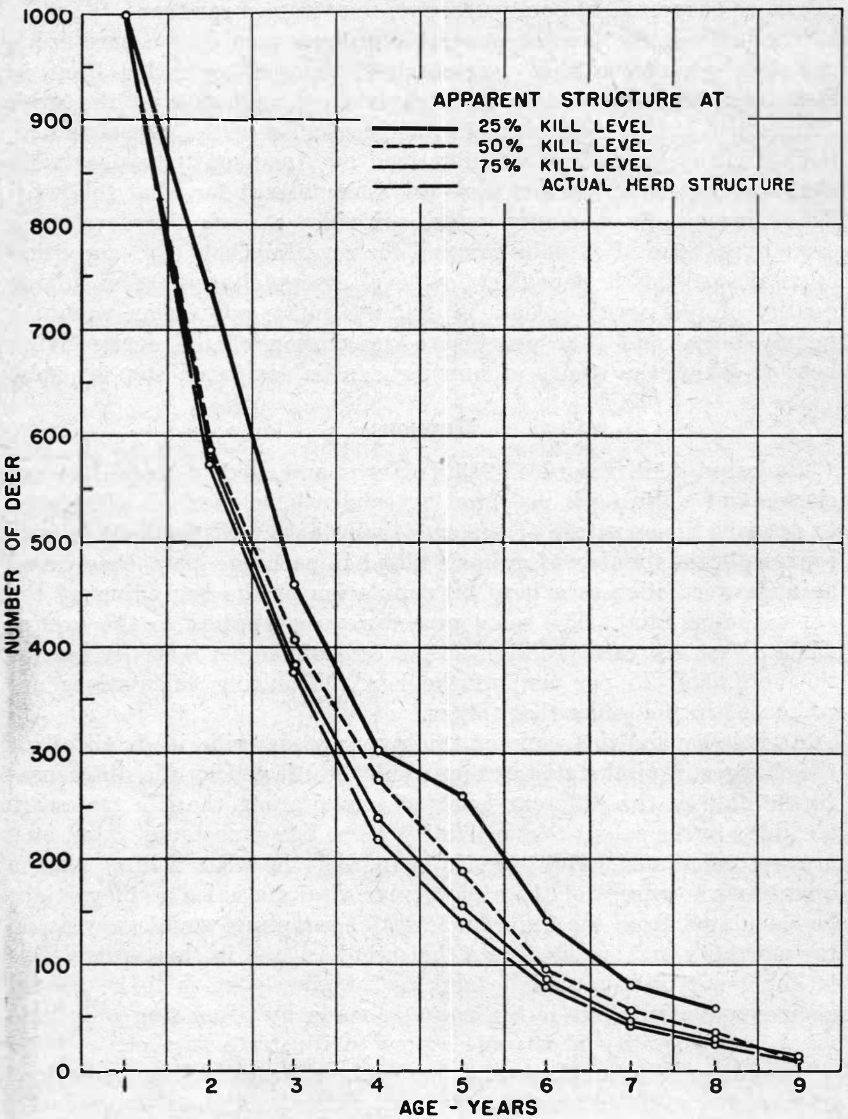

Figure 1. Survival curves illustrating apparent age structures in comparison to actual age structure.

Survival curves were plotted from the life tables to illustrate graphically the supposed structures or compositions of the populations as they would be represented by the several levels of sampling. Deviations of these curves are interpreted on an explorational basis. Although many interpretations can be made from the data that follow, only a few will be made as it is the purpose of this paper only to assist a movement toward direct population management.

INTERPRETATION OF LIFE TABLES AND SURVIVAL CURVES

The structure of the roe deer herd, as it appeared in life, is represented numerically in Table 1 and diagramatically in Figure 1, 100 per cent curve. Each age class appears in proportion to a fawn class of 1000 animals as it existed in a living condition. A survival curve plotted from the l_x column of the life table results in a smooth "j" shaped curve that is recognized as a type commonly occurring in normal unexploited populations as have been described by Deevey (1947) and Allee, *et al.,* (1949).

An actual numerical plot of the mortality record from the d column however, does not yield a smooth curve because the age classes in the living herd did not exist in direct proportion to each other.

This feature in a mortality curve also emerges when there is a differential rate of mortality between age classes. A mortality curve plotted from the d_x column of Table 1 necessarily conforms to the shape of the kill curve because it is directly proportional. In the mortality curve as commonly used in actuarial studies each age class is represented as the number dying within that age class out of a total of 1000 deaths. Thus, the distribution of mortality is indicated for each age class in the population.

A fundamental premise of life table methods is that survival and mortality are reciprocal functions in population dynamics and regardless of a variation of survival or mortality rates between age classes

TABLE 1. LIFE TABLE OF A ROE DEER HERD

Age	d	d_x	l_x
1	91	427	1000
2	41	195	573
3	34	159[1]	378
4	17	79	219
5	13	61	140
6	8	37	79
7	4	18	42
8	3	14	24
9	2	9	10
	213	1000	0

[1]Fractions were discounted in the following life tables.

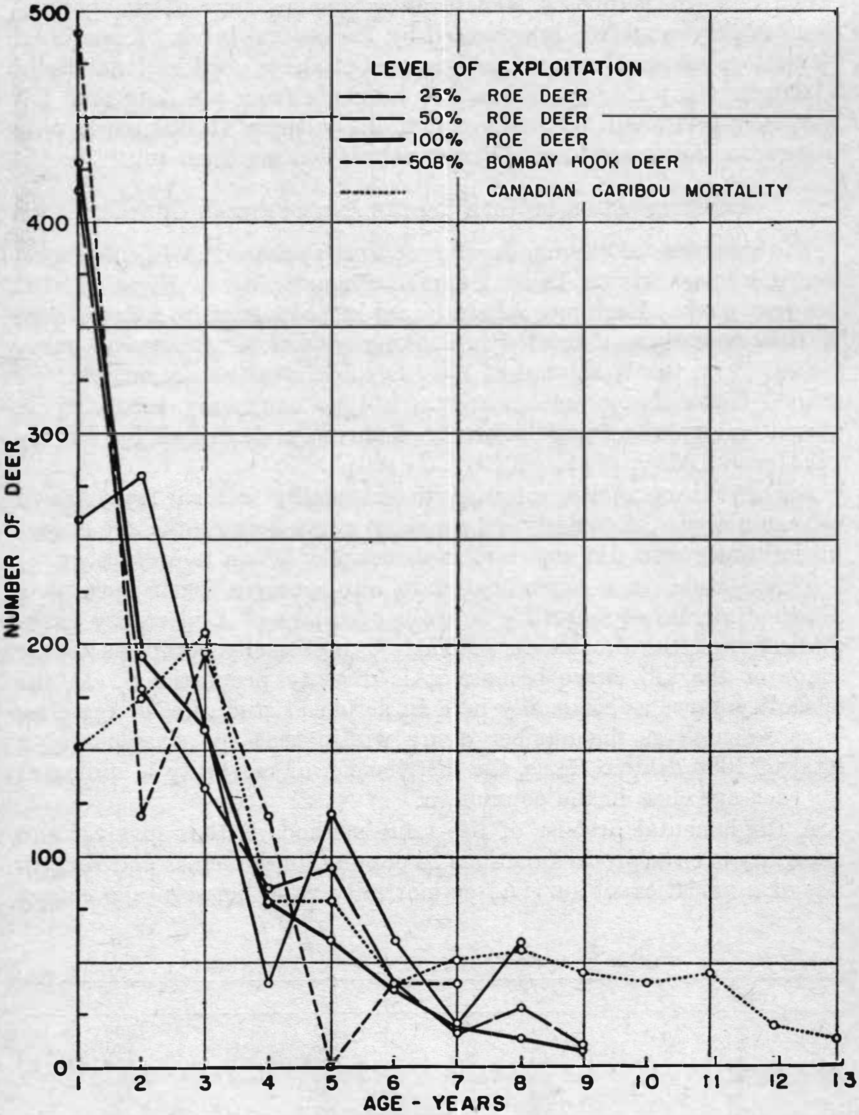

Figure 2. Mortality curves illustrating age specific mortality relations at various levels of exploitation.

the structure of a living population is revealed by the occurrence of mortality in that population. It follows from this that the frequency of age classes in kills should reflect the character of the surviving population. This is a patent fact only if the kill is an adequate sample of the population. In game kill records this requires, among other considerations, that hunter activity be non-selective and for this reason the roe deer data described by Andersen is of great value. In the discussion to follow, changes in the aspects of survival curves and mortality curves will be shown to be affected by the level of sampling.

POPULATION STRUCTURE AND KILL CURVE AT THE 25 PER CENT LEVEL OF EXPLOITATION

Although the legal kill of game species is sometimes known within practically accurate limits there is always the question of what proportion of the population has been exploited by hunting. Since the herd of roe deer was completely exterminated and an accurate record of the procedure kept, some insight can be gained regarding the appearance of mortality records in relation to what proportion of a herd has been exploited, what the structure of the surviving population is, and how vital statistics vary according to the level of sampling. The first 50 deer killed of the herd of 213 animals approximates the 25 per cent level of exploitation. A life table was prepared from this part of the data as if it were the only available kill record (Table 2), or in other words, as if the hunt ended at this point.

If one were to assume that the age classes in the kill (Figure 2, 25 per cent level) properly represented the age classes in the living population it would seem obvious that the fawn class was less numerous than the yearling class and that the four year old class was indeed very scarce. Further, the oldest animal in the population appears to have been eight years old. Under these same assumptions, the five,- six- and eight-year-old classes appear to have been more numerous in the population than was the four-year-old-class. Now, survival and

TABLE 2. LIFE TABLE FROM THE KILL OF 25 PER CENT OF A ROE DEER HERD

Age	d	d_x	l_x
1	13	260	1000
2	14	280	740
3	8	160	460
4	2	40	300
5	6	120	260
6	3	60	140
7	1	20	80
8	3	60	60
9	0	0	0
	50	1000	0

mortality curves from Table 2 can be compared to those from Table 1 to reveal errors in interpretation that might be made if the actual character of the entire herd were not known.

Survival curves (Figure 1) indicate that we could have over-estimated the relative sizes of these same age classes in the surviving population. This is illustrated by the manner in which the plotted curve representing supposed survivors of a hunt that removed 25 per cent of the herd lies above the plotted curve representing the herd as it actually was in life. (Each age class to be viewed as lying in proportion to a fawn class of 1000).

It is obvious in these data that the removal of 25 per cent of the herd did not exploit the separate age classes in proportion to their actual occurrence in the population. Another point that is brought out is that the 25 per cent level of exploitation did not expose the fact that there were animals older than eight years of age. While it might be immediately conjectured that "the wise old bucks" succeeded in evading the hunters, it is more probable that the escape of the nine year class was a function of chance, as it was in fact the smallest age class in the living herd.

The peak of the kill curve (Figure 2—25 per cent level) occurring at age 2 (upper limits used for identification of age classes) represents excessive vulnerability of this age class in comparison to the other age classes. This is an age class that is about to enter the breeding group and is important for its potential ability to recruit the herd, particularly because of its numerical superiority over other separate breeding age classes. This might prove to be an important point in herd management. Obviously, roe deer vital statistics would be erroneously represented if calculated on the basis of a 25 per cent level of exploitation.

POPULATION STRUCTURE AND KILL CURVE AT THE 50 PER CENT LEVEL OF EXPLOITATION

To further examine the usefulness of life table methods for appraising exploitation, the first 50 per cent, 106 animals, killed during the non-selective hunt can be examined by the same procedure. In Table 3, compiled from arrangement of the first 106 animals killed into age frequency classes, there is a notable smoothing of the representation of the age classes in the d_x and l_x columns. Projected as a survival curve, Figure 1, some of the humps are smoothed and the curve is extended from the eight to the nine year age class.

The kill curve from the d_x column shows that a drastic revision of the interpretations drawn from the 25 per cent kill curve are in order.

TABLE 3. LIFE TABLE FROM THE KILL OF 50 PER CENT OF A ROE DEER HERD

Age	d	d_x	l_x
1	44	415	1000
2	19	179	585
3	14	132	406
4	9	85	274
5	10	94	189
6	4	38	95
7	2	19	57
8	3	28	38
9	1	10	10
	106	1000	0

The fawn class and the yearling class fall into reciprocal positions, the fawn class now appearing to have been much more heavily exploited in comparison to the two-year class. However, in the survival curve (from l_x column), Figure 1, it still appears that the two-year class, when compared to the entire herd, has survived at a level above its actual status. We now know, too, that the oldest animal in the herd was nine instead of eight. This, of course, changes our concept of longevity and all other vital statistics.

Although the survival curve representing the 50 per cent level of exploitation approaches the smooth "j" shape of the original herd structure, all age classes still appear to have survived at a level relatively higher than they actually did. The close agreement of this curve, however, to the curve representing the actual living herd shows that at least half the herd had to be killed on a non-selective basis before the age structure of the kill simulated the age structure of the herd as it was in life prior to the hunt. It also follows that if this condition is obtained, the structure of the residual herd will be similar to the structure of the original herd, although, of course, it will be numerically smaller.

Under practical conditions if successive years of records indicate a repetition of humps and depressions in the same age classes it becomes evident that the records represent under-utilization of those age classes which seemed to have been poorly represented. This is made obvious by the fact that the age classes surviving one year will progress to the next older age class and therefore should appear in the record of the following year.

In summary, the continuation of hunting pressure up to the 50 per cent level of exploitation resulted in smoothing the curve and in simple terms agrees with an axiom of sampling that continued hunting resulted in more adequate sampling. Hunting, beyond the 25 per cent level exerted relatively more pressure on the fawn class because the next most numerous age class, the long yearlings or two year olds

TABLE 4. LIFE TABLE FROM THE KILL OF 75 PER CENT OF A ROE DEER HERD

Age	d	dx	lx
1	67	418	1000
2	32	200	582
3	23	144	382
4	13	81	238
5	11	69	157
6	7	44	88
7	2	13	44
8	3	18	31
9	2	13	13
	160	1000	0

had been depleted in the initial stages of the hunt and consequently fawns became more vulnerable.

At the 50 per cent level of exploitation about half of the fawn class was killed. Also, with this same hunting pressure, about half of the two and three year classes was removed. It appears from these data that the four and five year classes became more vulnerable at the level at which a numerical half of the herd was taken than at lower levels of exploitation. Reduction of the roe deer herd by half its population exterminated the eight-year-old class but took only half the nine-year-old class. Inasmuch as these classes consisted of only a few individuals it is problematical if the chance factors operated on this scale as they might on a larger one. It appears that a continued high level of exploitation would shorten the age base of the herd with the obvious effect of reducing the number of "capital" trophies in the herd.

EXPLOITATION AT THE 75 PER CENT LEVEL

The outstanding feature of the kill at this level is that it came closer to adequately sampling each individual age class than did the other levels of exploitation. Both the survival and the mortality curves for the 75 per cent level and the 100 per cent level show noteworthy parallelism and even the mortality curve approaches the "j" shape of a normal population structure.

In the light of the exceptional vulnerability of the two-year class at the 25 per cent kill level, exploitation at the 75 per cent level taxes the fawn class too severely to reserve enough fawns for adequate recruitment to the two-year class in the following year. It was cut below the base replacement level which in the case of the roe deer herd should have permitted 52 per cent of the fawn class to become two year olds. This should not be taken as a prescribed formula but rather only as an illustration of what mechanics were operating in the Danish roe deer herd at the particular time. It is, nonetheless, indicative of things to be considered in herd management.

100 PER CENT LEVEL OF EXPLOITATION—EXTERMINATION

Ultimate extermination of the herd provided the final tally of the distribution of age classes in the roe deer herd. Obviously, the mortality record (kill record) at this level of exploitation is numerically identical with the survival record of the herd before hunting began.

A mortality curve representing the frequency of death by age classes per 1000 deaths, conforms closely to the "j" shape of the survival curve. Both curves are now in close agreement with the deductions from other studies that most animal populations have age structures that conform to certain well-defined graphic figures. In the case of the roe deer, this structure appears to have been similar to the "rectangular" type recognized by Pearl (1940). ("Skewed" rectangular types have been suspected by demographers.) While the survival curve itself does conform to a "j" shape it is not quite paralleled by the mortality curve. This is a result of the mathematical procedure involved in actuarial methods and probably is also induced by slight abberations in the relative strengths of the age classes that resulted from previous hunting and emigrations. Even despite this it seems a significant fact that the structure of this herd of roe deer closely approximated the forms demonstrated in other populations (Allee *et al.*, p. 301).

TABLE 5. SEX-SPECIFIC LIFE TABLE: CALCULATED FROM KILL OF A NUMERICAL HALF OF A ROE DEER HERD

A. Males Age	d	d_x	l_x
1	26	456	1000
2	12	211	544
3	8	140	333
4	4	70	193
5	5	88	123
6	1	18	35
7	1	17	17
8	0	0	0
9	0	0	0
	57	1000	0
B. Females			
1	18	368	1000
2	7	143	632
3	7	143	489
4	4	82	346
5	5	102	264
6	3	61	162
7	1	20	101
8	3	61	81
9	1	20	20
	49	1000	0

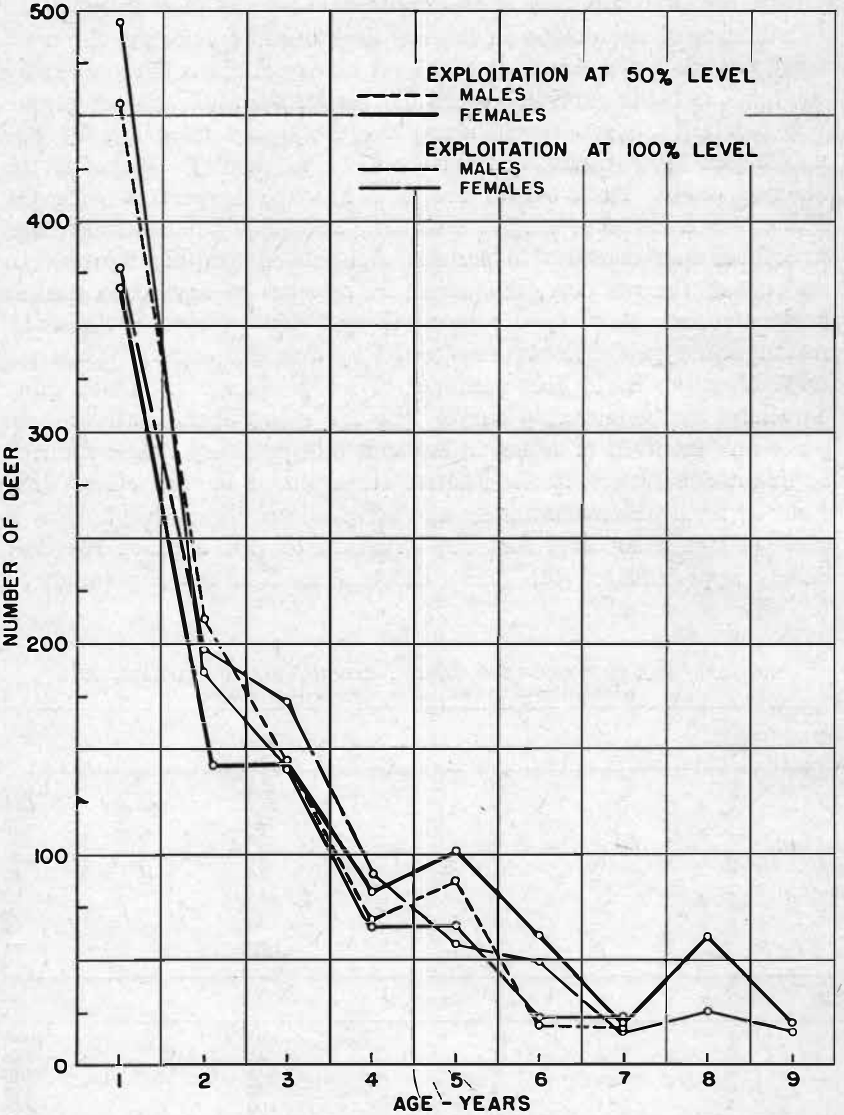

Figure 3. Sex-specific mortality curves at two stages in the extermination of a Danish roe deer herd.

SEX-SPECIFIC LIFE TABLES

It is a common practice in demography to segregate the sexes in making analyses of human population dynamics. This procedure, when applied to the roe deer data shows that some differences exist in the vulnerability of male and female deer.

Previous years of hunting and emigration had set up different male-female age structures to begin with in the roe deer herd. This was exposed upon final extermination of the herd when all animals were accounted and classified. Despite numerical equality in the fawn class (45 males to 46 females) the representation of bucks in adult age classes was erratic in comparison to the female segment of the population (Tables 5, 6 and Figure 3). In the life table method of illustration this tends to exaggerate the strength of the buck fawn class in comparison to doe fawns by elevating the fawn bucks to a position relatively higher than actually existed (Figure 3). Conversely, the strengths of the female adult classes are exaggerated in comparison to the male adult classes although it is true that the adult females were numerically superior.

The sex-specific kill at the 50 per cent level of the entire herd closely represented all age classes in their actual status but some divergence between the 50 per cent and 100 per cent mortality curves was indicated in the adult female classes at the five year class and over. Parallelism between the male curves at the 50 per cent and 100 per cent

TABLE 6. SEX-SPECIFIC LIFE TABLE: CALCULATED FROM THE EXTERMINATION OF A ROE DEER HERD

A. Males Age	d	d_x	l_x
1	45	495	1000
2	17	187	505
3	13	143	318
4	6	66	175
5	6	66	109
6	2	22	43
7	2	22	21
8	0	0	0
9	0	0	0
	91	1000	0
B. Females			
1	46	377	1000
2	24	197	623
3	21	172	426
4	11	90	254
5	7	57	164
6	6	49	107
7	2	16	58
8	3	25	42
9	2	16	17
	122	1000	0

levels is striking. Coincidence of these mortality curves at age 3 shows a high vulnerability of this age class of bucks.

Andersen has described some of the effects of hunting on sex structure of the herd but the use of life table methods permits age-specific appraisals of changes in herd composition resulting from various levels of hunting pressure. A few of the interpretations derived by Andersen that are also illustrated by life table methods are:

1. Males are more vulnerable than females; it will be remembered that deer were shot as they appeared irrespective of sex or age.
2. Young males are exploited before young females; they are reduced to a numerical status where females become more and more vulnerable.
3. The oldest females, seven, eight and nine year classes, are less vulnerable than the oldest males despite their numerical superiority and consequent likelihood of being shot under the conditions of Andersen's controlled hunt.

This is by no means all that can be learned by the application of actuarial methods of population analysis. A further tabulation of sex specific mortality would, when illustrated by mortality and survival curves representing different levels of hunting, show that the structural changes that resulted were not governed solely by the laws of chance. And, as Andersen stated it, "... the findings may be of some interest from point of view of shooting technique."

Data from Other Sources

In 1954 the U. S. Fish and Wildlife Service conducted a planned hunt on the Moosehorn National Wildlife Refuge for the purpose of reducing a herd of white-tailed deer. Prior to the hunt, herd size was estimated at 600 to 700 animals. Hunters checked out 343 deer, about 50% of the herd, classified by age. When these data are examined by actuarial methods it becomes apparent that different conditions existed here than were found in the Danish roe deer herd. In Figure 2 these data are plotted as a mortality curve. It indicates that the four-year class was nearly as large as the fawn class. As was pointed out in the report by Clark (unpublished, 1955) this area was severely over-browsed. Under this condition a shortage of younger age classes could be expected because of competition for feed. In the light of the roe deer data where two year olds were found to be excessively vulnerable at the 25 per cent level of exploitation it would seem that Clark's conclusions were correct since this age class appears to be poorly represented. Although hunter selectivity was not governed in the Moosehorn hunt there is some resemblance of the mortality pattern of the

Moosehorn herd to that of the Danish roe deer herd. The three-, four-, five- and six-year classes in the Moosehorn kill stand in similar proportion to the four-, five-, six-, and seven-year classes in the roe deer herd at the 25 per cent level of exploitation. It appears from life table methods of analysis that the hunt removed between 30 and 50 per cent of the herd and this is in agreement with Clark's estimate.

Similar information was obtained from a controlled hunt on the Bombay Hook National Wildlife Refuge. In 1954 the hunt removed 50.8 per cent of the herd. A mortality curve (Figure 2) constructed from these data conforms very closely to the data derived when 50 per cent of the Danish roe deer herd was killed. There is a notable agreement in the proportion of fawns killed to the aggregate adult age classes killed. Two slumps occur in each set of data but in different age classes. These are at two and five in the Bombay Hook white-tailed deer kill and at four and seven in the roe deer data. While it is improbable that we can deduce the cause of this from these statistics, it is of interest that the two sets of data seem to parallel each other at a 50 per cent kill level.

Banfield (1955) has prepared a provisional life table for caribou. This is based on a collection of mandibular rami obtained by various means, mostly from hunters. Predation, accidental death and disease are also involved as mortality factors and therefore the data do not relate strictly to "exploitation" from the standpoint of human activity. Banfield calculated his life tables in the same manner as Deevey and as those relating to the roe deer in this paper.

A mortality curve plotted from the d_x column directly from Banfield's table conforms remarkably with the data representing a kill of 25 per cent of the roe deer herd. The caribou fawn class is notably below the two- and three-year-old classes, there is a sudden plunge in the curve of the four-year group that coincides with that in roe deer, then there is an increased mortality at the five-year class with a drop in the sixth. A third peak occurs in the eight-year group with a gradual tapering off in the older age classes (Figure 2).

The vital statistics of caribou and roe deer being not too well known makes it difficult to appraise these differences with any confidence. Since the roe deer herd had been selectively exploited in the years prior to its final extermination, and trophy bucks sought, the age base must have been shortened. On the other hand, the caribou data is more likely to represent a "natural" herd with a longer age base more nearly expressing natural longevity. Hunting, however, should be suspected of having been selective, at least to a certain extent, and Banfield points out that the Eskimo seek calves and yearlings in particular. The kill data, however, do not show this even though it is known to be a common practice among Eskimo to take calves for special purposes. It should be remembered that roe deer fawns were not adequately sampled despite efforts to take any deer until 50 per cent of the herd had been killed. If it is true that calf caribou are under-represented, proper representation of this class would bring the survival curve into close alignment with that of the entire roe deer herd.

Banfield found that the basic form of the survival curve for caribou agrees with that prepared for mountain sheep by Deevey, and that in both records the fawn class is under-represented. It has already been shown that the roe deer herd structure also conforms to a basic form of population structure. Inasmuch as the mortality curve for roe deer at the 25 per cent level of exploitation closely approximates the caribou mortality curve it would seem that about 25 per cent of the caribou herd had been exploited.

A study similar in the intent of this one was done by Hayne (1952) for the purpose of estimating survival rates rather than estimating the effects of exploitation. Hayne has published deer kill data from two sources in New York. These data were collected by Severinghaus.

The method Hayne used for expressing survival was by plotting the logarithm of the per cent of total kill occurring in each age class against the numerical value of the age. This is essentially the same as the life table method. While the general conclusions reached by Hayne are rather well supported by the Danish roe deer data, further, an interpretation of level of exploitation is possible from these data. Two herds of deer are represented in the New York data. One, the Southern Tier buck kill, conforms to the standard "j" shaped survival curve that was obtained when the roe deer herd had been exploited at a level of approximately 50 per cent and beyond. The age base is shortened to 5½ years. In contrast, the Adirondack buck kill has an age base twice as long, running up to 9½ years. In addition, the curve derived from the Adirondack kill data indicates an ascending left limb, that is, the yearling class is not represented as strongly as the 2½-year class. This is in close agreement with the roe deer data at the 25 per cent level of exploitation.

It seems reasonable to conclude that the lower level of exploitation among Adirondack bucks permitted the development of a broader age base, the herd having not been as heavily exploited as the Southern Tier herd. Since only bucks are involved these inferences have no relation to the total herd and do not reflect the status of the total herd nor of its range.

SUMMARY

Studies of natural populations have revealed that age structures within populations tend to conform to rather consistent patterns. These can be expressed as survival curves; but, in order to appraise survival among game populations, we have at present only mortality records. Illustrations drawn from the roe deer population data described in Andersen's study show that an appraisal of survival varies with changes in the mortality records and that mortality records change with the level of exploitation. Valid concepts of mortality and survival appear to depend upon the intensity of hunting. This is compatible with the logic of sampling procedure and we cannot hope to make logical deductions about population dynamics unless the basic information on mortality or survival correctly represents the living population.

Andersen's study reveals that at least two factors stringently govern our ability to calculate vital statistics of game populations. First, hunter activity can result in direct selectivity with obvious bias, and second, there is a variation in the vulnerability of the sexes and the age classes that operates entirely independently of hunter selectivity. Although game biologists have recognized that these factors are operative, we have not had adequate data by which these things can be measured. The roe deer data provide a model for visualizing a procedure for the measurement of some of the parameters of population dynamics.

Estimates of the effects of exploitation can be made if it can be accepted that animal populations tend to maintain a normal structural pattern. Mortality curves plotted from life tables can be compared to normal survival curves and the level of exploitation estimated by the degree of alignment of the two curves. While years of changing laws have tended to upset a normal distribution of sex and age classes in game populations, there is reason to believe, from many studies, that other mortality factors operate that tend to maintain a normal structure in animal populations, within the framework of their particular biological characteristics.

It would be desirable to establish survival curves for game species by the methods used in the Danish roe deer study, that is, total extermination of a population unit. These would provide a knowledge of structural patterns to which kill records could be compared to ascertain the level of exploitation.

It does not seem that real game management can be accomplished without a knowledge of vital statistics and the dynamics of populations. Population management has been successful in Europe and, of

course, is the foundation of the livestock industry in the United States. Actuarial methods provide the quantitative descriptions of vital statistics that are needed in the management of game populations and offer a means of evaluating the effects of hunting on game stocks.

Even though a knowledge of vital statistics and population dynamics is tantamount to the highest development of game management it should be remembered that Leopold wrote "Continuous census is the yardstick of success or failure in conservation."

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BLACK BEAR RESEARCH IN NEW YORK[1]

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The Investigation was initiated in New York in 1956 to obtain life history information, particularly on aging, reproductive history, and movements of bears, in order to provide data for management. Determination of the status of bears in the State is also being accomplished. Live-trapping and tagging, to permit collection of data on movements, weight changes, relative tooth wear, longevity and reproduction has been the principal study technique.

Developing trapping and handling techniques with both culvert and steel traps, occupied the summer of 1956. Trapping efforts were doubled in 1957 with a second, three-man crew assigned to steel trapping. This crew was primarily equipped with No. 4½ traps, but No. 150 traps were tested and small numbers were effectively used later in the summer. Equipment of the three-man culvert crew was bolstered by four non-trailer mounted traps in addition to four trailer-mounted traps available in 1956. This crew was also equipped with No. 4N and No. 150 traps.

This paper describes culvert traps and culvert and steel trapping techniques, assesses the effectiveness of the three sizes of steel traps employed, relates handling techniques and treats the results of handling bears with drugs. A condensed description of the aging method used and of specimen materials collected in connection with development of an aging method is included. A summary of specimens collected and procedures in reproductive studies are treated briefly. The report also discusses age composition, weights and sex ratios of the 209 bears trapped and summarizes recovery data.

CULVERT TRAPS AND TRAPPING TECHNIQUES

The culvert trap is made of an 8′ by 3′ section of 20 or 16 gauge steel

[1]A contribution of Federal Aid in Wildlife Restoration Project W-89-R; Big Game Management Investigations. Project Leader is C. W. Severinghaus of the New York State Conservation Department. The work, begun in 1956, is on research contract to the Department of Conservation at Cornell University from the State Conservation Department. The research is being conducted by Hugh C. Black—a doctoral student under the supervision of Dr. Oliver H. Hewitt, Professor of Wildlife Management at Cornell.

[2]The physical problems of handling bears, the distances involved and the skills required called for a special kind of assistance, which was capably rendered by the following Cornell University wildlife management students: Howard Erickson, Frederick Knowlton and David Mech, in 1956; the latter two men returning in 1957 as crew leaders, with David Austin, Jay Eisenhart and Kermit Rinnell as assistants.

The cooperation of Greenleaf T. Chase, District Game Manager, and his staff in the Adirondacks during both years of the Investigation is gratefully acknowledged. Richard Hyde, District Game Manager in the Alleghany district, and trapper-assistants provided support on our brief foray into their District in 1957. Game Protectors of the Adirondack District gave valuable assistance in the field.

Guidance and assistance was also generously provided by the staff of the College of Veterinary Medicine and by Dr. W. A. Wimsatt, Professor of Zoology, at Cornell.

Figure 1. Spraying ether into trailer mounted culvert trap to anesthetize bear. Note weighing bracket mounted on truck.

culvert pipe, closed at one end with a ventilated steel plate. The opposite end is closed by a guillotine-type door of quarter- or eighth-inch steel, 3 feet square. A simple trigger mechanism consists of a bait-and-trigger rod linked together. The door is supported by the trigger rod and the bait suspended on the bait rod within the trap. A tug on the bait causes the bait rod to act like a toggle, advancing the trigger rod and releasing the door. No catch is used to secure the door (Black, 1957).

The four culvert traps used in 1956 were all trailer mounted (Figure 1). In 1957, three, non-trailer mounted traps were constructed of 20-gauge pipe and 11-gauge end plate and door. Smaller ventilation holes provided better ventilation, reduced damage to tooth and claw and permitted rapid sealing with masking tape. Strength of the lighter traps was demonstrated by the capture of a 599-lb. bear. Cost of a trailer-mounted trap was approximately $250 and of the lighter gauge traps less trailer, about half this amount.

Trailer mounting permitted ease of handling and was valuable for transportation of bears. Apparently it did not reduce trap effectiveness, nor did painting of the traps impair their success.

Culvert Trapping Techniques. Most trapping was done at sites of bear activity within the Central Adirondacks, during the summers of 1956 and 1957. The same sites were retrapped in the second year. Direct night observation aided in locating traps very close to frequently used trails. This was found important because, with the abundance of food available, bears were not easily lured more than a few yards. Traps were mainly baited with smoked pork jowl, which proved very effective and also possessed many desirable bait properties. Baits of about one pound were fastened to the trigger rod with soft wire. A "bacon trail" consisting of slivers of bacon led directly into the trap. Other baits including rough fish, deer meat from kills, meat scraps and honey were tested in 1956, but were inconclusive.

Setting the Culvert Trap. Where convenient, the trailer mounted trap was backed against an incline, thereby providing an easy approach for bears. Frequently the wheels of the trailer were "dug in," timbers were placed around the open end of the trap and earth was banked around the entrance. The tongue was always blocked up to take most of the weight off the springs, making the trap more stable. Earth or sod was spread inside the trap to counter possible wariness. Non-trailer mounted traps were simply placed on the ground and set; braces welded to the pipe assured stability.

STEEL TRAPPING TECHNIQUES

Experimentation with steel trapping techniques was begun late in 1956, with 12 No. 4½ traps. One bear was captured after 43 trap nights. Three cubs were taken in No. 4 traps. Consultation with Albert W. Erickson, Game Biologist, Michigan Conservation Department, and the opportunity to observe the handling of two bears taken in steel traps in Michigan was very helpful.

Four contiguous areas in the Central Adirondacks were trapped during the summer of 1957. This region is essentially represented by one cover type—beech, birch and maple with admixture of spruce—modified by cutting. Blowdown, fire and site conditions influenced cover locally. Terrain was mountainous and elevations within the region ranged for the most part between 1,500 and 4,500 feet. Most of the area was privately owned, principally by lumber companies. Roads and trails were limited and few habitations present. In fact, the unimproved road network built by the loggers provided our principal means of access over most of the areas trapped. Their abandoned camps served as our headquarters as well.

Set Location. All sets were located alongside or near gravel roads in order to allow daily checking of the lengthy trap lines. Presence of fresh bear sign was considered sufficient reason for a set. The most commonly observed signs were tracks or trails, droppings, evidences of feeding and miscellaneous signs of bear activity, in that order. Actual sight observations should not be discounted, since in practically all cases where a set was made near and following a sighting, a bear visit was soon recorded. Spacing was dependent on character of the range, availability of food and amount of sign noted throughout the area. One-half to three-quarter mile intervals were commonly used; the sets being located with respect to game trails and skid roads and their junction with the main road. Due to the frequent paucity of sign, more sets were arbitrarily established than were located with respect to sign or sightings.

Spacing was as close as 0.1 mile, where an abundance of fresh sign existed. Sometimes two or rarely three sets were located very near each other if sign warranted and suitable sites were available—increasing the chances of taking a bear or even two bears at the same site. Sets were maintained for two to three weeks, but the shorter period may be more often recommended.

Uniformity of habitat and abundance of food did not influence bears to move widely, although local movements were noted. Raspberries constituted the one abundantly available and readily taken summer food.

Making the Steel Set. Methods devised in Michigan by Erickson (1957) were closely adhered to in 1956 and at the outset of trapping in 1957. Experimentation resulted in a set that proved nearly 100 per cent effective (Figure 2).

Essentially a small cubby set was arranged so that a bear could enter only in the desired manner. Logs, cull pulpwood, stumps or large rocks were used to build the set in five steps, as follows:

1. The set was located against a bank, stump, tree, rock outcrop, etc., so that an impenetrable "back door" was created. If a bank were selected, a hole was dug into it to prevent access from the sides.
2. Two cull pulpwood bolts made an ideal set with a minimum of effort. They were placed in an open V, with bait in the apex. On a bank set they were slightly inclined, otherwise they were laid flat. Inside spacing was about two feet at the outside edge of the trap and less than one foot at the closed end. Additional protection was added at the back of the set in the form of brush or logs as needed.
3. Traps were set with the jaws parallel to the center line of the set and located about 4 inches to the left or right of the center line. The traps were dug in so that when covered the pan would

Figure 2. Adding lure to steel trap set. Offset position of trap indicated by guide sticks.

be slightly lower than the ground surface. Denim trap cloths were employed to cover the pan and earth was sifted over the firmly bedded trap. Nothing was placed under the trap pan.

4. Four guide sticks, one to two inches in diameter, boxed in the trap. The outermost stick (the stepping stick) was separated by three inches from the outside edge of the trap jaws. The sticks were all firmly laid to avoid their being brushed into the trap jaws.
5. A small piece of bait was placed in the back of the set and secured with a forked stick. Thirty inches was found to be the most suitable interval between bait and the inside edge of the trap jaws. Commercial lures were frequently added. A bait trail was then scattered near the set, which was completed by addition of a warning sign.

Baits and Lures. Smoked pork jowl, used exclusively on the steel traplines, proved a highly successful bait. Only three avoidance reactions were noted out of a total of 126 bear visits in 1957 and two of these were recorded at the same set. One-half to one pound pieces of bait were generally employed, but there were indications that even smaller pieces would be equally effective. Hawbaker's standard formula bear lure with anise added and some special lures Hawbaker compounded for our testing were used in conjunction with the bacon, but did not increase trapping success.

Trail Sets. This type of set was occasionally used in wild trapping. It was particularly effective in taking cubs following capture of the female. Also, making a cluster of trail sets for cubs saved much time. Guide sticks were employed as before, although in this case stepping sticks were spaced-out on both approaches to the trap. Special care was taken to prevent a bear from stepping on the trap dog and more attention was given to making the set inconspicuous. The trap was always dug in, but was sometimes covered with grass or leaves in place of trap cloth and earth. One large female was taken in a No. 150 trap in a trail set in water!

Steel Trapping at Dumps. No. 150 traps were successfully employed at dump sites. Constant surveillance of the traps was necessary because of the presence of people and a desire to remove the bears before attention was attracted. Heavily used paths leading into such sites presented ideal conditions for use of trail sets. Artificial conditions about such sites often enabled effective placement of traps with a minimum of set preparation.

Cup Capture with Steel Traps. Cubs were occasionally taken in the wild or at dump situations in No. 4½ or No. 150 traps. More often they were taken in No. 4N traps following trapping of the female or they were deliberately trapped at dump sites prior to trapping the female. In the former case, techniques were necessarily flexible to meet each new situation. Generally the cubs treed. Ringing the base of the tree with traps to take the cubs was not satisfactory. A cub might be taken, but more often they either jumped completely outside the traps or stepped around them. Erection of a "cub-proof" barrier was not feasible. However, a tangle net might provide an effective and easily erected barrier.

A more efficient technique was to climb after the cubs with the aid of climbers and place a No. 4N trap on a cub's foot by hand. The cub was then lowered by means of a rope attached to the trap. But climbing tall hardwoods is dangerous without the added hazard of handling cub bears.

Curiosity and the less wary behavior of cubs when in the presence of their mother suggested an alternative approach, *e.g.,* deliberately trapping the cubs and in turn using the trapped cubs to entice the female into No. 150 traps placed about them. This method produced the fastest action and it is not without an element of excitement, but where more than one female with cubs was frequenting the same site it did increase the chances of confusing the relationships of cubs to females.

HANDLING PROCEDURES AND EFFECTIVENESS OF DRUGS

Drugs were used in handling all but one of 209 bears processed. Pentobarbital sodium was used on 75 bears, including all bears taken in steel traps. One hundred and thirty were handled with ether and 13 bears were administered succinylcholine chloride. Twelve known-age bears were also handled with this drug. Pentobarbital sodium was used on some culvert-trapped bears that were initially anesthetized with ether. Succinylcholine chloride was also used in a few cases to hold bears that had first been anesthetized with ether.

Culvert Trap. The trap was sealed before ether treatment was begun. Three traps were modified to permit bolting steel plates over the apertures, but wet paper towels over the vents provided a tight seal. Masking tape was used to close the vents on three non-trailer mounted traps. A fourth non-trailer mounted trap was rectangular and constructed of pierced steel plate. Bears were handled in this trap with succinylcholine chloride, transferred to a culvert trap for handling or caught in a steel trap and removed for processing.

Commercial grade ethyl ether was sprayed into the trap with a one-quart size continuous operation sprayer. Spraying was continued until the bear became quiet. During etherizing the actions were observed with the aid of a flashlight.

Care must be taken that the nozzle of the sprayer is kept out of reach of the bear. Constant vigilance is necessary during the short interval after spraying of ether until the bear is removed. Crew members must be alert to remove the bear from the trap immediately, should respiration stop. Respiratory stimulants were available for emergency use.

Our procedure was to maintain continuous watch over the respiration rate and to check the animal's condition visually. Respiration rate was not a precise indicator of degree of anesthesia. At time of removal from the trap, respiration rates ranged from 10 to 30 per minute.

Anesthesia required an average of 1.2 pounds of ether per bear, which was sprayed into the trap in about 9 minutes. The following responses are averages based on handling of 130 bears with ether: violent movements occurred in 6 minutes, bears became quiet and inactive two to three minutes later; spraying was continued for another minute and one-half, followed by removal of the bear in an additional two minutes. Bears were maintained under anesthesia by repeated applications of an "ether cone"—an 8-quart bucket containing a layer of cotton saturated with ether. They were held under anesthesia for 20 to 30 minutes; and required 2 to 6 minutes to recover before moving off. One bear was kept under ether for an hour and 45 minutes, without apparent ill effects. The bears rapidly regained muscular control and coordination although they initially exhibited actions akin to drunkenness. All moved away from the operators following recovery.

Steel Trap. All yearling and adult bears taken in steel traps were first subdued with a choker and ropes and were then anesthetized with an intraperitoneal injection of pentobarbital sodium. This handling technique, developed by Erickson (1957), was also used on cubs, often with substitution of a smaller, dog choker. A 6½-foot choker handle of one-half-inch steel pipe worked very well. Persons using this device should be cautioned to be sure that handles are tight and the chain loop is welded together—we put a choker on one bear in the 125-pound bracket without benefit of trap, but lost it when the chain loop came apart. The bear left. Two men successfully handled bears up to 317 pounds in steel traps. But for bears this size and larger a three-man handling crew is recommended.

One cc. of pentobarbital sodium (60 mgm/cc concentration) per 5½ pounds body weight was the average dosage required to produce anesthesia, which lasted from one to several hours. Slightly less was required for cubs and correspondingly more care should be exercised in its administration to them. A cautious injection technique was followed. The bear's weight was estimated, the dosage was calculated and half the estimated dosage was injected. The remainder of the dose was administered after 10 minutes, or a portion of it depending on the bear's reactions.

Complete relaxation was achieved with "Anectine," a brand of succinylcholine chloride produced by Burroughs Wellcome and Co. The drug causes muscular paralysis by producing a blockage of nervous transmission at the myoneural junction. Complete muscular paralysis is of short duration followed by extremely rapid recovery. A simple device consisting of a 10-cc capacity Ranch Record syringe mounted in a clamp on a 7-foot rod was devised to administer the drug. The syringe was preferably thrust into the muscles of the rear quarters. Rapid closure of the syringe and successful injection was effected at the instant the 16- or 18-gauge, 1½-inch needle pierced the skin. Intramuscular injections averaging 27 mgms per 100 pounds body weight at concentrations of 20 and 50 mgms/cc were used. Relaxation resulted within as short a time as one minute after injection, but the average time was close to 3 minutes.

Handling Difficulties. Mortalities during handling resulted in the loss of one bear following use of pentobarbital sodium and three bears after use of ether. One bear also died from the use of succinylcholine chloride. And one stopped breathing following use of pentobarbital sodium, but recovered upon application of artificial respiration. This bear had been given a full dose of pentobarbital sodium before complete recovery from ether. Artificial respiration was also successfully used on a bear whose respiration had ceased during anesthesia with ether.

PROCESSING PROCEDURES

Bears were ear-tagged and standard measurements were taken, including an age estimate. Estimates were based on relative tooth wear as compared with a series of known-age skulls carried in the field.[1] Two sizes of monel metal ear tags, manufactured by the National Band and Tag Co., were used. The larger, cattle-size tag was adopted in preference to the size designed for sheep and hogs. Paint marking was accomplished experimentally on 8 bears to provide a temporary means of identification. The paint mark on one bear observed 8 days after marking was obscure, but aided in identification. Toe clipping was used experimentally on one bear. Unilateral castration was performed on 97 males with no apparent inimical effects. Testes were measured upon removal and gross sections of the testis and epididymus were fixed to permit histological examination. This technique was designed to provide information on minimum and maximum breeding ages and periods of spermatogenesis. Antibiotics were administered intramuscularly as a prophylaxis.

Thirty-two females were sacrificed and genital tracts were recovered and fixed to allow studies of reproduction.

RESULTS OF CULVERT TRAPPING

Fifty-six bears were culvert-trapped, including one retrap, during the summer of 1956. Five were transported alive to the College of Veterinary Medicine at Cornell University for autopsy. The remainder were ear-tagged and released. Trapping success averaged one bear for every three culvert-trap nights. In 1957, 88 bears were culvert-trapped, including 10 retraps.

Operation of the culvert traps was extremely simple and successful. Trap shyness and avoidance reactions were noted in both summers, but constituted a more serious problem in 1957. Trap shyness was dis-

[1]A series of seven known-age bear skulls obtained from the State Conservation Department constituted the basis for assigning age estimates in the field; examination having indicated the possibility of assigning ages within broad limits based upon relative tooth wear. An additional nineteen known-age bears were obtained from zoos in New York, autopsied, and skulls, long bones and pelvic girdles collected.

played by bears entering the trap but not grasping the bait. A treadle operated trigger is suggested to counter this behavior, since springing the trap would then be a passive action. Avoidance behavior amounted to "indifference" to the trap. Reasons for these actions, observed mainly in August and September of 1957, were not clear. Bears were trapped at some sites during the same periods using the same baits with none of the above difficulties.

RESULTS OF STEEL TRAPPING

Steel trapping during the first summer was limited and experimental. Four bears were taken; three were cubs trapped in No. 4 coyote traps and the fourth was a sub-adult taken in a No. 4½ trap.

In 1957, steel trapping operations were highly successful. Sixty bears were taken in three sizes of steel traps under three different conditions, *i.e.,* in the wild, at dumps and in taking of cubs. This was done safely with but two serious injuries sustained by bears handled (none by the handlers) and without a single unfavorable incident.

Steel trapping on wild ranges with No. 4½ traps and employment of steel traps (both sizes 4N and 4½) to take cubs extended over the entire summer. Two modified No. 150 traps were put in operation on wild ranges in mid-June and four more in mid-July. Beginning in late July No. 150 traps were used at dumps and from early August three were used concurrently with culvert traps.

Wild trapping operations in 1957 comprised 3,081 trap nights; more than 200 additional trap nights were realized at dump sites. Practically all of the trap nights were with the No. 4½ trap. Results of 2,732 corrected trap nights in the wild were as follows: 126 bear visits were recorded; 37 "misses"; 42 escapes; 4 trap misfunctions; 14 miscellaneous and 29 captures. It is interesting to note that this is exactly the number of bear visits (126) that Erickson (1957) reported for 2,393 corrected trap nights of steel trapping in 1956. A great many small animals were caught. Raccoons headed a list which included snowshoe hares, porcupines, red squirrels, chipmunks, red foxes, crows, one great horned owl, two skunks and six feral housecats; the latter were taken in the vicinity of an abandoned lumber camp. Nine bobcats were caught, five of which were ear-tagged and released. One of two fisher caught was released following tagging and the single coyote taken was tagged and released. This animal, incidentally, which was the first tagged coyote released in New York, was retrapped by a coyote trapper two months later and 24 miles from the release point. It was reported in excellent condition and had gained seven pounds since release (17 to 24 lbs.).

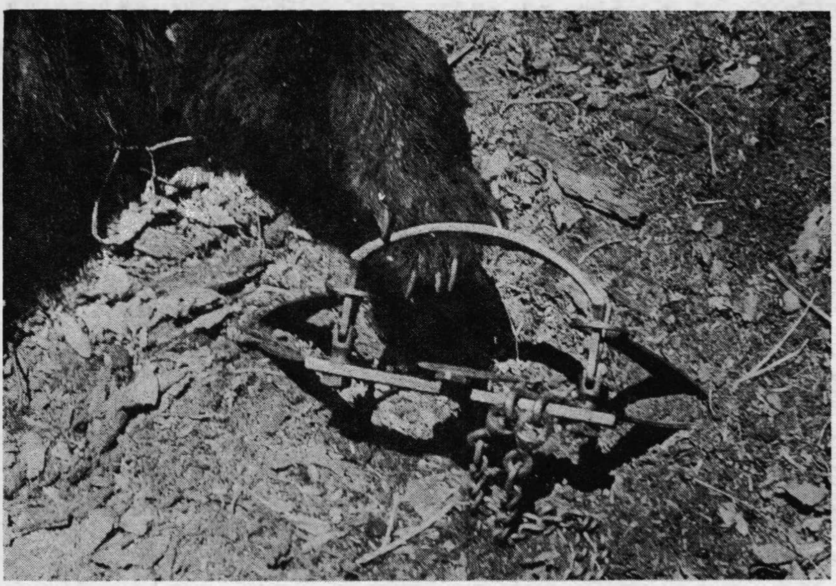

Figure 3. Precarious catch of a 328-pound male held by only two toes in a No. 4½ trap (third toe pad not caught by jaws).

Trapped bears did not move far from the set before "hanging-up" or escaping. Some were taken not more than a few feet from sets and this was true of all cubs. The average distance moved before the drags became fast, based on all steel-trapped bears, was about 200 feet; bears which escaped had moved shorter distances from the sets on an average. However, one bear taken in June had succeeded in pulling the trap and drags more than a half-mile. Trap-drags in this instance were made of reinforcing rod, which was inferior, and was replaced by hot rolled steel. (Two drags of one-half or five-eighths-inch steel rod, one attached with six feet of chain and a second "safety drag" on a 1½-foot section of chain, were used on all Nos. 4½ and 150 traps.)

Bear misses were initially high because sets were not perfected: 29 misses were registered out of the first 71 bear visits; all on the first area trapped. But only two bear misses were realized out of the remaining trapping effort, attesting to the effectiveness of the sets (Black, 1958).

The No. 4½ Trap (Figure 4). This trap did not prove as effective as hoped. More than half the bears well "caught" in this trap escaped; note the hold on a 328-pound bear in Figure 3. Considering other trapping problems, results were not good enough. Only one catch for each four or five bear-visits was registered. This was at the rate of about one catch per 100 trap nights. The number of bears pulling-out, especially of larger bears, precluded obtaining valid age composition, sex ratios or average weights of bears in the wild.

Weights of bears taken in the No. 4½ trap ranged from a 24-pound cub to 317- and 328-pound adults. This last is believed to be the heaviest bear ever taken in a No. 4½ trap. A 195-pound bear was caught in a No. 4N trap.

Efforts are being made to increase the efficiency of this trap by addition of springs to the trap drag chain. Observations indicated that substitution of a heavier swivel, drag and drag chain would overcome the disadvantage of double drag chains to twist together and eliminate swivel action, enabling a bear to pull-out more readily.

The No. 150 Trap (Figure 4). Experimental use of this trap in 1957 stemmed from a desire to find a more efficient trapping method. Two No. 150 traps, with teeth removed, were placed in operation in mid-June. This trap with its offset jaws and larger size looked so good that four additional traps were placed in operation by mid-July.

Nineteen bears were taken with No. 150 traps. Weights of the 16 yearlings and adults and three cubs ranged from 40 to 361 pounds.

Figure 4. Comparative size of Nos. 150 and 4½ traps and drags. Six-inch scale on No. 150 trap. Note offset jaws.

Surprisingly, the lightest bear taken in this trap was a 1½-year old female weighing only 40 pounds. It should be noted that 12 of the 19 bears were handled within a few hours after capture; all others were handled on the day following setting of traps. No injuries were sustained, with one freak exception, in which a small male hung-up the trap in such fashion that three toes were separated. Only five bears incurred even slight skin breaks.

These results demonstrate the safety and effectiveness of the No. 150 trap, *with teeth removed,* for research trapping. Its effect on a bear's foot is possibly less damaging than a No. 4½. Certainly chances of toe loss are negligible, due to the offset jaws. Also, the fact that one small sub-adult and three cubs were taken without any injury suggests that it may be even safer on cubs than the No. 4½—again probably accounted for by the offset jaws. Finally, many small animals cannot spring the trap and raccoons, etc., either spring it without being caught, or may pull-out without injury.

Effects of Steel Traps on Bears' Feet. All Steel Trapping. Most (43 of 64) of the bears caught incurred no injuries. Fifteen had minor cuts, two had deep cuts, bones of the forelimb were broken on two cubs and one bear suffered separation of the joints of three toes. Of 42 bears which escaped, 14 lost one or two toes.

ESTIMATED AGE COMPOSITION, SEX AND WEIGHTS OF BEARS TRAPPED

Two hundred and nine bears were processed; 60 were trapped in 1956, including one retrap, and 149 were processed in 1957. Of this latter number 125 were trapped for the first time. Eighty-eight of the 1957 total were taken in culvert traps, 60 were taken in steel traps and one was shot. Full scale steel trapping and an increase in culvert trapping marked results which more than doubled the 1956 take. All bears trapped were of black color phase.

The main difference between results in the two years was in the size of bears taken. This is partly due to the larger 1957 sample. In 1957, six male bears exceeded 400 pounds, two of which weighed a record 562 and 599 pounds. The latter is the heaviest New York bear on record. The heaviest female weighed 361 pounds. The heaviest bear trapped in 1956 was a male weighing 391 pounds. The heaviest female taken the same year weighed 299 pounds.

Tables 1 and 2 show weights by estimated age and sex. The average weights of males and females combined were not computed by estimated age because of the disparity in size between sexes.

More younger and comparatively smaller bears were trapped in the wild. Trapping was selective for smaller bears, because of extensive

TABLE 1. WEIGHTS BY ESTIMATED AGE AND SEX OF 54 BEARS TAGGED IN 1956[2]

Age	Males	Average Wt.	Females	Average Wt.
cubs	2	23 lbs.	1	17 lbs.
1½ yrs.	4	98	2	132
2½-4½	31	235	3	178
>4½	7	346	4	226
	Total 44	Average 230 lbs.	10	172 lbs.
LESS CUBS	Total 42	Average 240 lbs.	9	189 lbs.

TABLE 2. WEIGHTS BY ESTIMATED AGE AND SEX OF 125 BEARS TRAPPED IN 1957[3]

Age	Males	Average Wt.	Females	Average Wt.
cubs	11	40 lbs.	10	40 lbs.
1½	13	97	7	76
2½-4½	45	259	9	164
>4½	18	368	12	214
	Total 87	Average 229 lbs.	Total 38	Average 131 lbs.
LESS CUBS	Total 76	Average 257 lbs.	Total 28	Average 164 lbs.

[2]Age estimates of the first six adult bears tagged were assigned by weights.
[3]One hundred and twenty-five bears were trapped or processed for the first time in 1957. For purposes of age composition, sex ratios and weights, the 12 bears initially tagged in 1956 and retrapped in 1957 are included in these totals. Bears trapped twice in 1957 are not included. One cub tagged and released subsequent to being caught and held in captivity is not included. Also not included are 10 unaged bears and one bear not weighed.

use of the No. 4½ trap. Perhaps one of the most remarkable findings was the wild trapping of five yearling males that weighed an average of only 64 pounds; three weighed 52, 55 and 55 pounds. The average weight of five yearling females was only 73 pounds, and three of these weighed 40, 47 and 68 pounds. A 40-pound female, taken in a No. 150 trap, had been killed in the trap by another bear. No flesh was consumed, however.

Sex ratios in the wild were conspicuously different. More than half the bears trapped were females; the computed ratio, based on 29 individuals, was 58 females per 100 bears. This compared to only 25 females per 100 bears at dump sites (17 females to 83 males were recorded in 1956). When cubs, whose sex ratio was nearly even in 1957 (45 female to 55 male) are excluded, the ratios were slightly more lopsided; 62 females per 100 bears in the wild as compared to 20 females per 100 at dump sites in 1957. The sex ratios, age composition and weights found in the wild are probably more indicative of the true population than is the dump-trapped sample. Differences in behavior between the sexes during the summer apparently accounts for the preponderance of males at the latter sites.

SUMMARY OF TAG RETURN DATA, DISTANCES MOVED, WEIGHT CHANGES AND TAG DURABILITY

Fifty-three tagged bears have been recovered to date; six in 1956 and the remainder in 1957. Returns were obtained from 14 hunters ($25.00 reward payment was made for return of ear tags, skull and kill location data); from bears shot out of season (6), from retrapping (25) and from sight records (7); one return was obtained from a train mortality. These returns resulted from the tagging of 54 bears in 1956 and 87 in 1957, a total of 141 individual bears tagged.

Forty of the 53 tagged bears recovered had been transferred less than one mile and 13 had been transferred an average of 42 miles (Table 3). Bears in the first category had not moved far, being recovered an average of 3.2 miles from the trap sites and 3.6 miles from the release points. The average weight change of 21 bears weighed in this category was a gain of 53 pounds. However, bears that had been moved before release were recovered many miles distant from both trap and release points; averaging 34 and 27 miles removed respectively. Mean weight changes in this group indicated a gain of 42 pounds, based on nine bears weighed.

Four of the 13 bears transferred clearly demonstrated homing behavior. A male returned 32 miles to the original trap site in 8 days and another male was retrapped near the original trap site following release 43 miles distant the previous year. It is pertinent to note that

TABLE 3. SUMMARY OF TAGGED-BEAR RECOVERY DATA

	Total	Average Distance Moved	Average Distance from Trap Site	Average Distance from Release Point	Number Weighed	Mean Weight Change
			NOT MOVED			
Recovery within 1-2 wks.	12	0.5 mi.	1.1 mi.	1.6 mi.	4	+ 3 lbs.
Recovery within 1-4 mos.	15	0.9	3.8	4.0	8	+42
Recovery approx. 1 yr.	13	1.1	4.5	5.2	9	+86
Total/Average	40	0.8 mi.	3.2 mi.	3.6 mi.	21	+53 lbs.
			MOVED			
Recovery within 1-2 wks.	1	32 mi.	0 mi.	32 mi.	0	....
Recovery within 1-4 wks.	4	61	69	21	3	+ 8 lbs.
Recovery approx. 1 yr.	8	34	21	30	6	+59
Total/Average	13	42 mi.	34 mi.	27 mi.	9	+42 lbs.

the six females recovered were all taken at or close by the place first trapped.

An interesting response to release some 50 or more miles from the trap points was demonstrated by five bears transferred in 1957. Three were taken by hunters and one of the two remaining was sighted, all at distances of 15 to 27 miles from the release point and in random directions from it.

Eight of the 12 bears tagged in 1956 and retrapped in 1957 were not transferred. All showed gains with the exception of one female which had lost 23 pounds. Weight increases varied from zero to an astonishing 230 pounds on a 332-pound male that tipped the scales at 562 pounds in 1957.

Twelve bears, 11 males and one female, were trapped twice in 1957. This represented the third capture for two bears, which had been first captured in 1956. Only two of the 12 bears were transferred, and those only 3.3 and 6 miles. This group showed significant weight increase in most cases when the interval between captures was more than 3 weeks. Two truly remarkable gains of 92 pounds on a 341-pound male and 81 pounds on a 236-pound male, both over a period of 3 weeks, were recorded.

Tag Durability

Small, sheep-hog size tags were used on the first 30 bears tagged in 1956, but larger, cattle-size were used on all bears tagged subsequently. Nineteen pairs of small tags and 35 pairs of large tags were represented in the 53 recoveries. A large tag was used to replace a small tag lost on one retrapped bear and this bear was counted as having both a large and a small "pair" of tags.

One bear lost both cattle-size tags in one year. Tag scars in both ears were well healed. This bear was identified by the scar left by the removal of one testicle the previous summer and by tag scars. Six other bears lost one tag, four of which were of the small size and two of cattle-size. All of the bears losing one or more tags had worn them approximately one year, with the exception of one bear tagged with large tags in 1957 and shot 3½ months later.

These data demonstrate that ear tagging bears with monel metal tags of sheep-hog, or cattle-size tags is a satisfactory marking method. Available data indicate a slight edge in favor of the larger tag. The chance of losing both tags is slight, but for this reason careful observation should be made of any unusual markings, scars or abnormalities. A premolar count and careful dentition notes are particularly valuable aids in identifying a recovered bear.

SUMMARY

An investigation of the black bear was initiated in New York in 1956 to obtain life history information, particularly on aging, reproductive history and movements. Live-trapping and tagging to permit collection of data on movements, weight changes, relative tooth wear, longevity and reproduction has been the principal study technique.

Two hundred and nine bears were handled; 144 were trapped in culvert traps and 64 in Nos. 4N, 4½ and 150 steel traps. One was shot. Techniques for handling and processing procedures are described.

Drugs were used in handling 208 of 209 bears processed. Dosages for ether, pentobarbital sodium and succinylcholine chloride and methods and devices used for administration are indicated. One bear each was lost following use of pentobarbital sodium and succinylcholine chloride and three from ether.

Culvert traps, both trailer and non-trailer mounted, took one bear per three trap nights in 1956; less in 1957. Sixty-four bears were steel-trapped under three different conditions, *e.g.*, in the wild, at dumps and in taking of cubs. This was done safely; only two serious injuries were sustained by bears handled and none by handlers. Results of 2,732 corrected trap nights in the wild in 1957 were as follows: 126 bear visits were recorded; 37 "misses"; 42 escapes; 4 trap misfunctions; 14 miscellaneous and 29 captures. A great many small animals were caught.

Average distance moved before the trap drags became fast was about 200 feet; bears which escaped had moved shorter distances from sets.

Weights of bears taken in the No. 4½ trap ranged from a 24-pound cub to 317 and 328 pound adults. A 195-pound bear was caught in a No. 4N trap.

The No. 4½ trap did not prove as effective as hoped. More than half the bears well "caught" in this trap escaped. Only one catch for each four or five bear visits was registered. The numbers of bears pulling-out, especially of larger bears, precluded obtaining valid age composition, sex ratios or average weights of bears in the wild.

With only two modified No. 150 traps in operation from mid-June and six from mid-July 1957, 19 bears were taken with no serious injury. Weights of the 16 yearlings and adults and 3 cubs ranged from 40 to 361 pounds.

Most, 43 of 64 bears steel trapped, incurred no injuries. Fifteen had minor cuts, two had deep cuts, bones of the forelimb were broken on two cubs and one bear suffered separation of the joints of three toes. Of 42 bears which escaped, 14 lost one or two toes.

The average weight of 54 bears tagged in 1956 was 220 pounds and

of 125 bears in 1957 was 200 pounds; excluding cubs, mean weights were 231 and 232 pounds. Mean weights of males and females less cubs in 1956 were 240 and 189 pounds. Comparable figures in 1957 were 257 and 164 pounds. Six male bears exceeded 400 pounds, two of which weighed a record 562 and 599 pounds. The latter is the heaviest New York bear on record. The heaviest female weighed 361 pounds.

Fifty-three tagged bears were recovered; six in 1956 and the remainder in 1957: returns were obtained from hunters (14), from bears shot out of season (6), from retrapping (25) and from sight records (7); one return was obtained from a train mortality. These returns resulted from ear-tagging of 54 bears in 1956 and 87 in 1957, a total of 141 bears tagged.

Two sizes of monel metal tags were used. Nineteen pairs of small and 35 pairs of large tags were represented in the 53 recoveries. Six bears lost one tag, four of which were of the small and two of the cattle-size. One bear lost both cattle-size tags. All but one of the bears had worn the tags approximately one year.

Forty of the 53 tagged bears recovered had been moved less than one mile and 13 had been moved an average of 42 miles. Bears in the first category were recovered an average of 3.2 miles from trap sites and 3.6 miles from release points. Bears that had been transferred before release were recovered many miles distant from both trap and release points. Four demonstrated homing behavior.

The average weight change of 21 bears weighed that had not been transferred was a gain of 53 pounds. Mean weight changes in the transferred group indicated a gain of 42 pounds, based on nine bears weighed. Weight increases for a year interval were negligible on three bears, 51, 134 and 230 pounds on a 332-pound male that weighed 562 pounds when recaptured. Twelve bears retrapped up to three months after trapping showed weight increases in most cases. Two remarkable gains of 92 pounds on a 341-pound male and 81 pounds on a 236-pound male, both over a period of three weeks, were recorded.

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DISCUSSION

DR. W. G. SHELDON [Massachusetts]: I would like to ask whether you could hazard a guess as to the density of bears on the basis of square miles of area or information such as that?

MR. BLACK: That is a comprehensive question and I cannot answer it now. We are attempting to collect information that will permit the answer. I might point out that the habitat within our area is uniform throughout and our trapping procedures should give us some indication of the population density. I would not want to make an estimate of the population density now.

MR. HALE [Wisconsin]: Do you want to make an estimate of how far a trapped bear should be removed from a nuisance situation, such as a dump?

MR. BLACK: I can give you the information that we have. We transferred five bears more than fifty miles in each case, across forest area and agricultural lands and into a separate bear range. Those were animals transferred in 1957 and, during the past hunting season, four of five were accounted for. They had moved in random directions from the release point (not necessarily back to the original point) but some 15 to 27 miles from it. We have had four instances of returns after moving. It does appear that at fifty miles there would be small likelihood of bears returning, particularly if there is intervening non-bear range.

MR. LAWRENCE [Washington]: In connection with a damage control program on six thousand acres we removed approximately five hundred animals—nearly four animals per section, and that was considered excellent bear habitat.

MANAGEMENT OF THE BIG GAME RESOURCE IN UGANDA, EAST AFRICA

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During the period from October, 1956, to June, 1957, the authors were engaged in ecological research on big game populations in Queen Elizabeth National Park, Uganda. There were opportunities, however, for travel throughout the Protectorate observing land use patterns, big game abundance and distribution, and methods of administering the game resource. Because of their length, our more detailed comments will be reserved for later publication. We discuss here the viewpoints on management of the big game resource which we feel have interest outside Uganda.

Our work in East Africa was supported by Fulbright research grants. Dr. William Gaines and Geoffrey Watt, United States Educational Commission in The United Kingdom, London, were most helpful in making the many necessary administrative arrangements. An additional grant toward travel expenses was supplied by the Conservation Foundation and New York Zoological Society through the cooperation of Dr. Fairfield Osborn. Harold J. Coolidge, Natural Resources Council, was instrumental in the establishment of the project. In Uganda, we were given all possible assistance especially through the good offices of the Honorable R. L. E. Dreschfield, R. M. Bere, and the trustees of the Uganda National Parks, Major B. G. Kinloch, D. H. Rhodes, T. R. H. Owen, A. M. Anderson, and C. J. H. Simpson of the Uganda Game and Fisheries Department, Dr. A. J. Haddow of the Virus Research Institute, Prof. L. C. Beadle of Makerere College, and C. Swabey of the Forest Department. In addition generous field assistance was given by Capt. F. Poppleton, Park Warden, and by W. O. Pridham, A. M. H. Henley, J. Stoneman, J. M. Warren, J. H. Blower, K. B. Robson, J. B. Heppes, R. F. Newton, and J. R. F. Mills of the Game and Fisheries staff. Messrs. Bere and Kinloch reviewed the manuscript and made several helpful suggestions. To all, and to their wives and families, we wish to offer our most sincere thanks for their generous hospitality, help, and friendship.

It should be recognized that the authors' viewpoints are those of biologists and natural area preservationists. Their suitability for application must be determined by the Uganda Administration in relation to political, educational, and other local factors. They are offered, however, in a spirit of helpfulness, with the recognition that the administration of colonial and protectorate areas has never been more difficult. It is hoped that some of the ideas expressed will be useful to the officials in Uganda who are charged with responsibility for the game and national park resources.

DESCRIPTION OF THE COUNTRY

Uganda is one of the smaller countries of the huge African continent. But, in general, its scenery is more attractive, its climate is more ideal, and its inhabitants are more interestingly varied than in most other similar-sized parts of Africa. It is 94,000 square miles in area and is located 500 miles inland from the Indian Ocean. It is bisected by the equator and partly surrounds Lake Victoria, the second largest lake in the world. Most of its lands are rolling and lie at altitudes varying from 2000 to 6000 feet. Several parts of the country are mountainous, however, with the Ruwenzori ("Mountains of the Moon") range reaching nearly 17,000 feet high and supporting permanent and extensive glacial ice. The varied topography and resulting climatic contrasts result in a varied vegetation pattern. There are some desert or near-desert areas and some bamboo and rain-forests, but most of the country is either open short-grass plains or bushed long-grass savannahs. The grasslands are burned with moderate frequency.

HISTORY AND LAND USE

It was in 1862, less than one hundred years ago, that the first European entered what is now Uganda. It was only in 1900 that the present area was declared a British protectorate. A year later, Uganda was linked by rail and Lake Victoria steamer to Nairobi and to the Indian Ocean, but not until 1931 did the railway reach Kampala, the major city. Many a person is living today who can easily remember Uganda as a country of limited populations, inferior crops, scarce livestock, numerous and frequent diseases, common tribal warfare, and considerable wild animal populations.

In the last 58 years, under British administration, extensive medical and veterinary services and established peace have resulted in considerable increases in both human and livestock numbers. Sugar, cotton, and coffee have become principal commercial crops and new species and improved varieties of food crops have been introduced. Railway, steamer, and bus services now reach into most parts of the nation. Road systems are continually being expanded and improved. Mines and hydroelectric power have been developed.

Intensive cultivation now occupies much of the central part of the country and large areas elsewhere. Heavy livestock grazing has altered grassland habitats in some districts, but overgrazing is not as widespread as in Kenya (Petrides, 1955). Resettlement areas have been established to accommodate the increasing human population. Fishing and fish processing have become commercial operations on all the large lakes and some of the smaller ones. Where large blocks of land are not cultivated or heavily grazed, there may be settlements depending upon fishing, mining, forestry, railroads, and similar industries.

Increasing human populations and their use of the land are drastically limiting land in Uganda for native wild game. Especially because of the damage they cause to crops and even to tree plantations, big game in East Africa must be maintained mostly on wild lands, if it is to be preserved for the future. Most of the still-wild lands have been preserved until the present by the tsetse fly. Some areas have been closed to entry because of human sleeping sickness carried by the fly, but most of these insects carry livestock trypanosomes which effectively limit settlement. All fly-infested areas are somewhat bush-covered; tsetses do not live in open country.

Tsetse-infested areas and other wild lands still are extensive but they are becoming increasingly isolated from each other by strip-settlements along the roads. Furthermore, control of tsetse flies has been and still is being accomplished by selective bush-clearing in conjunction with game destruction which leaves such areas with only the smaller game remaining. Progress is being made also in developing medicinal preventatives for livestock trypanosomiasis. By whichever method tsetse control is achieved, however, the eventual result is occupation of the land by man and his livestock with consequent displacement of game. The tsetse fly in East Africa can be thanked for saving game areas until now, but its power in the face of modern control procedures seems to be nearly at an end.

THE GAME RESOURCE AND ITS ADMINISTRATION

There are about 30 species of hoofed animals in Uganda, ranging in size from tiny dik-diks to large buffaloes and giraffes. Both the more-common black and the rare white rhinoceros occur in the country. There are ten of the larger carnivores, ranging from the bat-eared fox, aard-wolf, and serval cat to the hunting dog, leopard, cheetah, and lion. There are numerous miscellaneous mammals ranging from the aardvark to the elephant. The primates include numerous monkeys, the chimpanzee, and mountain gorilla. There is a wide variety of song and game birds, from miniature kingfishers and sunbirds to the giant bustard and ostrich. The monitor lizard and crocodile are conspicuous among reptiles. The great variety of thrilling large animals is certainly one of the country's outstanding attractions. A visitor can experience a thrill today amidst East African game that must be akin to that felt by men in Pleistocene times.

The rich animal life of Uganda is not evenly distributed throughout the country. There are six major faunal regions. These generally coincide with the major vegetation types (Snowden, 1953). Each has a distinct assemblage of the big game species, as well as of smaller birds, mammals, and other organisms. On these biotic regions has been superimposed the varied land use pattern alluded to earlier. This factor affects the distribution and abundance of animal life remaining in each faunal area. Both the faunal and land use regions will be discussed in more detail in later publications. The terms "game" and "big game" are used loosely in this report, as they are in Africa, with reference to the larger mammals whether they are in fact hunted or not in the area under discussion.

The African's outlook on wildlife depends on his background. Residents in urban and agricultural areas may never have seen an elephant or lion. They are intensely interested even in stuffed animals. These people, who are in the majority in some areas, offer hope for interest in wildlife preservation if they can be educated in its full values. But in non-agricultural rural districts, at present, probably not one in ten thousand Africans has any appreciation of game animals except as food. The Swahili word *nyama* means either meat or animal. There are no separate names for these things in many other African languages.

The traditional African outlook toward game reflects centuries of constant watchfulness and battle to thwart the killing of livestock and sometimes humans by lions and other predators. Destruction of essential crops by elephants, hippos, rhinos, and various large herbivores also had to be guarded against. In 1925, an Elephant Control Department was formed to assist in crop protection. In the same year, that organization was revamped into a Game Department with broader functions, but a principal activity of the Department even today is game control.

At its inception, despite its primary functions in game control, the Game Department (Uganda Protectorate, 1927) accepted the responsibility of preserving the wild game in some parts of the country. Hunting regulations required a license, established bag limits, and controlled the types of weapons used. Through the years, increasing efforts have been made by a dedicated staff to reduce the still widespread use of snares and other illegal procedures. As early as 1925, too, several areas were set aside as game reserves. Some of these were of large size and were established with the intent of permanence. Other smaller areas were set up with hopes for at least long-time preservation.

In 1952, a National Parks Ordinance (Uganda Protectorate, 1952) was proclaimed. This provided "for the establishment of national parks for the purpose of preserving wild animal life, wild vegetation, and providing for other matters incidental thereto." In that same year, the two present parks, Queen Elizabeth and Murchison Falls National Parks, were reserved.

MANAGEMENT OF GAME LANDS

Legal protection of big game on lands open to hunting has been largely through licensing and bag limits. There are no annual closed seasons except as imposed naturally by the two annual rainy periods of about two months each. Lands designated for game preservation in Uganda are of three types: game reserves, game sanctuaries, and national parks.

Game Reserves. Early reports of the Game Department (Uganda Protectorate, 1927-1930) reveal that these were established with the administrative intent of permanently providing for game preservation through complete reservation. They all were in then-existing sleeping sickness areas which were closed to entry. No legal provision for permanent assignment of the land, however, was made. The principal original reserves on Lakes Edward and George and at Murchison Falls have now been included in national parks. The only remaining game

Figure 1. Lightly grazed *Themeda* grasslands in Queen Elizabeth National Park, Uganda. May, 1957.

reserves are small ones at the west end of Lake Albert and in extreme southwest Uganda, adjoining Queen Elizabeth National Park.

The two remaining reserves are not only few in number but are small in size, and have several self-defeating characteristics. As two of the game reserves have been converted to national parks, it is apparent that some of the shortcomings of this type of area have been recognized by the Uganda government. But since the game reserve concept is still retained in other countries in Africa (where sleeping sickness was not a widespread factor), perhaps the apparent weaknesses of these areas in Uganda should be listed:

1. *Game reserves are not closed to settlement.* Although a European visitor usually may not camp legally without a permit, local Africans may graze livestock, cut wood, cultivate crops, or carry out any other activity they wish, except hunting. Thus land uses which may be inimicable to the preservation of game habitats are quite legal now that entry restrictions are weakened. It is true that adverse land-use activities in game reserves are normally discouraged by district officials, but no certain permanent protection against habitat destruction is provided. Whether reserves are viewed primarily as areas on which to maintain game or as places to raise game for harvest across

Figure 2. Gully system due to overgrazing of *Themeda* grasslands by hippopotami in Queen Elizabeth National Park, Uganda. Compare depth with height of man. May, 1957.

reserve borders, the loss of the land to other purposes would be fatal.

2. *They are not game areas for the legal hunter.* Game reserves are entirely closed to hunting. If game becomes abundant therein, this may be taken as proof of the effectiveness of the refuge. If it fails to increase, then the need for the reserve is seen to be all the greater. In either case, these lands, usually the best game lands, are withdrawn from legal hunting.

3. *They give the appearance of preserving game when they may not provide for its future.* Most maps of Uganda show these reserves and most educated residents and visitors believe that these areas provide definitely for the future of the game they contain. Since the reserves are not permanent, the interested public may be misled.

Uganda game reserves originally may have had some values in setting aside lands for the future. But now they seem quite vulnerable to loss and serve to divert public and administrative attention from the problem of providing adequate game protection. Uganda's present reserves could be put to better use. This is equally true for the national reserves of Kenya, and for the game reserves of Tanganyika, the Sudan, and probably other African territories. It is our suggestion that they be reassigned and managed either as national parks or as public hunting or game-ranching areas (see beyond).

Game Sanctuaries. These are areas in which either selected species (such as the white rhinoceros and mountain gorilla) are designated as being especially protected from legal hunting, or all game species are temporarily so protected. Game Sanctuaries in Uganda have all the weaknesses of game reserves plus those inherent in their limited objectives. They are even more misleading when displayed, as is frequent, on maps of the country.

National Parks. Two fine areas have been set aside as national parks. Queen Elizabeth National Park, on Lakes Edward and George, contains about 750 square miles. Murchison Falls National Park, on the Victoria Nile, is approximately 1100 square miles (Uganda Dept. Information, 1954). According to the National Parks Ordinance (1952), these areas are dedicated to the permanent preservation of wild animal life and wild vegetation. They are governed by an interested and conscientious Board of Trustees.

The national parks in Uganda are new, having been organized in 1952. They are neither sufficiently numerous nor widespread, however, to contain samples of all the important types of Uganda vegetation and animal life. Furthermore, both of the established areas still have problems concerning African settlers interested in cultivation, grazing, fishing, wood cutting, mining, or hunting. Provisions to overcome these invasions and to foresee and thwart those likely to occur in the future must be made.

The major difficulty at present, however, is with the big game populations of the areas. The overabundance of certain animal species threatens important plant communities which not only are intrinsically valuable but which also comprise food supplies for the game. Over large portions of Queen Elizabeth National Park, at least, overgrazing is causing great damage also to the soil.

Tabulations of our animal population and ecological data are not yet complete. In round figures, however, in mid-1957 we censused over 14,000 hippopotami utilizing about 300 square miles of grassland in Queen Elizabeth National Park. These animals normally spend the daylight hours partially submerged in open water or mud wallows. They feed at night on land. Adult hippos weigh 2500-4000 pounds and wet weights of grasses in the stomach after a night's feeding normally were over 400 pounds. In addition to 40-odd hippos to the square mile, one of our study areas also supported average populations of seven elephants, ten buffaloes, eight waterbucks, seven wart hogs, 1.5 kobs, and 1.3 bushbucks per square mile during the November 1956 - June 1957 period.

Over wide districts of the park, overgrazing by hippos was strikingly evident. Not only were grass communities degraded over most of the overgrazed lands, but even annual weeds were struggling to survive in many places. Thorn scrub was invading the grasslands. Much bare ground was evident. Dust storms occurred with each high wind. Gullies up to 50 feet deep were eroded in some slopes and advancing uphill at rates of over 50 feet per year. Evidence from vegetation and gullies, and comparisons of present conditions with photographs taken ten to twenty years previously, indicated that much of the hippo increase must have occurred within recent years.

One wonders why the hippopotami should have rather suddenly increased in abundance. For at least 25 years, Lakes George and Edward and the connecting Kazinga Channel have been known as places of high hippo densities (Uganda Protectorate, 1931). The only rather recent change in conditions occurred when the entire region was declared closed to human occupancy in 1929 because of endemic sleeping sickness of humans. Since then, and especially in the last decade or so, hunting has been forbidden. Increasingly effective patrolling has

Figure 3. Aerial view of lands overgrazed by hippopotami. Queen Elizabeth National Park, Uganda, January, 1958.

Figure 4. Savannah trees apparently overbrowsed by elephants. Murchison Falls National Park, Uganda, April, 1957.

been undertaken and it is perhaps significant that overgrazing is not evident today in the few less-effectively patrolled portions of the Park.

There is some question whether lions and other large predators are less numerous today than was once the case. These animals wander widely. The park has several elongate arms which especially make it likely that movements outside the Park will occur. There they may be killed by Africans guarding livestock. It is perhaps generally true of most natural areas surrounded by settled country that large predators are less common than would be true under widespread open-country conditions.

But lions are not known to kill hippos, except perhaps very rarely a young one. Diseases, too, are not frequent. In a small stagnant pool containing about 20 hippos, once during our stay we found three or four dead ones. Allan C. Brooks, now Uganda Game Department biologist, reported (verbally) that these deaths were diagnosed by the Uganda Veterinary Department as being due to anthrax. But the disease did not spread and there is no history of important hippo diseases in the area.

The only apparent factor that could have once limited hippo numbers seems to be hunting by Africans. Despite frequent deaths in

Uganda due to truculent hippos, groups of African hunters do not hesitate to attack the animals with spears. Snares of steel cable also are used to catch and hold hippos, and drop-spears, pits, and similar illegal methods may be quite effective. It would seem that a moderate population of hippos might well be prevented from increasing by such hunting and trapping. At least, no other explanation offers itself. The high population is real: it is altering the vegetation-type; it is causing changes in land-forms; it has limited food supplies for some game species and has completely destroyed them for others; it is disturbing the beauty and game-viewing potentialities of the area for visitors; and it is destroying the flora for whose protection the park was in part established.

If widespread additional wild lands were available for inclusion in the Queen Elizabeth National Park area, perhaps the range damage could be tolerated in the hope of an eventual natural collapse of the hippo population. But wild lands in this district are limited. There is little if any new land for expansion.

There are other parts of Queen Elizabeth National Park where currently less severe but still serious overgrazing is due largely to buffaloes and kobs in combination, and to topis. Elephants also seem to be preventing the growth of new *Acacia* and *Cordia* trees in several districts of the Park. In addition, in the areas which are overgrazed by hippos, elephants kick out and eat annual weeds which form the only hope for soil cover and they browse the less-thorny invading shrubs, thus encouraging the prickly and undesirable *Grewia* scrub. In the case of the elephants at least, it seems likely that their recent increase is due in a large measure to concentrations induced in the Park by increased human densities and land use outside.

In Murchison Falls National Park, Dr. H. K. Buechner is now obtaining more detailed information, but several wooded areas there appeared to us to be heavily overbrowsed by elephants. In addition, some forests of tall trees have been almost completely killed by elephants removing the bark with their tusks, thus girdling the tree trunks. The elephants at Murchison Falls may not be seriously depleting their food supplies since they perhaps can survive on grasses alone, but certainly they are damaging their more favored browse plants. Here again the wild fauna is strongly affecting the flora which the park was established in part to protect.

Recommendations

Paraphrasing Leopold's (1933) definition of game management, wildlife preservation might be said to be the art of managing lands, and their flora and fauna, for the sustained production of animal life *50 to 100 years hence.* Broadening the subject, wilderness preservation might be defined as the art of managing lands for the permanent maintenance of native plants and animals in a natural abundance and variety and with a minimum of disturbance by man.

The preservation of wild organisms and natural areas requires a thorough knowledge of animals and their environmental relationships. It also depends, however, on keen foresight being applied toward envisioning all possible changes that might occur in human population levels and uses of the land. It necessitates an efficient use of available educational, political, and legislative processes to erect effective safeguards of public opinion and law. These safeguards would be designed not only to legally barricade the area to be preserved against encroachments; they would also develop the viewpoints and values of the reserved area so that public use and appreciation would support its permanent maintenance in a natural state.

The following thoughts are based on the above comments and on these premises:

1. That much of Uganda's character and considerable tourist income would be lost if further wildlife depletion occurs.
2. That under African conditions, big game preservation requires areas of suitable game habitat set aside primarily for that purpose.
3. That in Uganda as elsewhere, there are important cultural and economic benefits both from game-viewing and from hunting (see Petrides, 1955), and that national parks will provide for the first and hunting reserves for the second.
4. A point which will be further developed: that on the limited areas nowadays available for the maintenance of wild lands, some management may have to be undertaken, even on dedicated natural areas, in order to preserve the permanent and unspoiled character of the wilderness.

Hunting Reserves. As in many other countries, it seems to us to be desirable to have some wildlife areas set aside in Uganda for public recreation and game preservation through hunting. Hunting reserves would have several advantages. They would provide for:

1. Substantial production of meat.
2. Important recreation; an outlet for the energies and tensions of the people.
3. Possible tribal income from safari hunters.
4. The preservation of some public lands for future recreational needs.

5. The managed preservation of native fauna and flora and perhaps of some local beauty spots.
6. The possible harvest of overabundant national park animals, where the areas can be located adjacent to national parks.

Modern techniques in ecological investigation and game management permit adequate estimations of game population levels, rates of increase and survival, and proper rates of kill. It is practicable to manage game herds on a basis which will insure preservation of both the game and its habitat, and yet provide for a regular harvest of meat.

The great variety of wild grazing animals in Uganda is an important asset. The large total number of animals in some areas, at least in part, may be due to an efficient use of the forage resulting from the varied feeding habits of the several species. Also some herbivorous animals have been found to be attracted to forage fertilized by the excretions of other grazing species (Etter, 1953). This also may enable a variety of game to make more efficient use of vegetative foods than would a game population made up of fewer species. These factors plus evidences of high carrying capacities of some African grasslands (Petrides, 1956), indicate that in addition to the management of wild ranges, properly managed ranching of wild game animals on modified grasslands also is a distinct possibility. Game ranching would seem to be especially worthy of serious thought as a source of high protein food in areas of protein deficiencies. Since game animals are immune to the trypanosomiasis that affects domestic stock, costs of tsetse bush-clearance often may be avoided. Thus, game may be preserved, with profits accruing both from meat production and cost of tsetse clearance.

Recreational opportunities for rural Africans are relatively few. Hunting has an important place in the tradition of most tribes. Either with modern weapons or with primitive individual or tribal methods, hunting could be undertaken on designated areas with no harm to the game population. Such hunting must be regulated, of course, under the guidance of trained game ecologists. When hunting is so regulated, however, preservation of both game and its habitat may be as permanent as on a non-hunted area. We believe that adequate and suitable lands dedicated to hunting and game production should be set aside in each important tribal area.

The establishment of public or tribal hunting is a matter of keen interest to the Game Department and to several of the present district officials. Sleeping sickness reserves in which the disease is now controlled are especially suitable for this purpose. There are also a number of other suitable places. Probably in order to encourage African interest, low-priced licenses offering a limited kill should be established, and hunting by other races should be under an additional permit which would return a fee to African local councils. There would seem to be a definite place in Uganda for safari hunting operations, however, and provisions should be made for such services. These would have considerable national income value and would stimulate the non-hunting tourist trade.

The proposed hunting areas would somewhat resemble the controlled shooting areas in adjacent Kenya but would differ in several important respects:

1. The lands would be legally designated as being dedicated to game production.
2. The game herds would be under constant careful management.
3. Hunting by local residents would be given priority over, but should not eliminate, safari parties.

National Parks. An adequate system of national parks seems to us to require efforts in two principal directions: (1) to expand the present national park system, and (2) to undertake game population control wherever this is needed within the system.

It is most desirable to bring into the system adequate samples of Uganda's major biotic areas. Fortunately, fine areas of unspoiled country still seem to be available in scenic locations. These samples of African wilderness have national and international values and deserve permanent preservation. They will be discussed in more detail in later reports. Some are adjacent to important fresh-water big-game fishing waters.

The viewpoint is occasionally expressed that some wilderness areas should be set aside as strict reserves purely for scientific use. It is our belief that as time goes on, pressures for other uses of lands so designated would prevent the application of this policy in Uganda. It would be better, we think, to provide for reasonable public use of a wilderness so as to stimulate a demand for its maintenance. Access to some portions of such an area, however, may be controlled. This could be done unobtrusively through the limitation of facilities but, if necessary, could be accomplished through entry permit requirements.

As to game population control in present national parks, there is a recognized difference of opinion. It is our sincere belief that in Queen Elizabeth National Park management must be directed now primarily toward a reduction of hippopotamus numbers. Controlled hippo harvests could be set up either by shooting on land at night or as a sort of ''whaling'' operation in daylight using boats with harpoon guns. The project could be carried out on a continuing, inconspicuous, and profitable basis. Alternative arrangements for primitive hunting seem to offer practical difficulties.

Doubtless there will always be overgrazed vegetation near the larger bodies of water. But hippos ranging some miles to pasture merely damage range lands over wide areas which are valuable also to other species. There would seem to be little benefit in maintaining a hippo population of more than 4,000 to 6,000 animals. Visitors having the opportunity to see one-third the present number would still be quite satisfactorily thrilled. Reductions to this level should be made as rapidly as possible. Regular harvests then should attempt to maintain hippo numbers at a level which permits at least a gradual improvement of range conditions. As this is being accomplished, further observations should be made toward the necessity for the local management of kobs, buffaloes, topis, and elephants (the latter perhaps in both parks).

Efforts may have to be made to overcome suggestions for additional waterholes, salt stations, pasture seeding, and fencing *unless* such procedures are associated with simultaneous hippo reductions. Otherwise, even aside from the costs involved, additional problem areas will be created by a still-expanding hippo population and perhaps by concentrations also of other game.

We recognize that many people feel, as we do ourselves, that there should be some forests somewhere that do not show the marks of an axe or saw. Somewhere stands of trees of representative types should be allowed to grow, mature, and die, without concern that lumber is being wasted. These areas substitute cultural, scientific, recreational, and other economic values for their timber assets. There are many people who feel that nature similarly should be allowed an unmanaged course for some animal populations. If animals destroy their food supplies and die, they say, let them do so. The cycle eventually will repeat itself and habitat and animal life will recover.

But the overgrazing problem does not parallel the forest situation. Dying trees enrich the soil and tend to perpetuate at least the climax vegetation. In contrast, overabundant herbivores may destroy the vegetation and often important soil conditions. Perhaps through the centuries such a completely-affected area would recover slowly, but even assuming that some animal life survived there to see that day, such recovery would be exceedingly slow. Much will depend on the severity of the inflicted damage and on the availability of additional lands. But, in general, can we afford, in a crowded world, the destruction of limited wild lands? Will lands so destroyed be saved for a comeback perhaps a hundred years or more in the future, or will it be taken during that time for other purposes?

Looked at in another way, national parks nowadays often exist as islands in a sea of land used or planned for other purposes. Like all island biotas, those of such natural areas are more susceptible to destruction than are the biotas of extensive lands. Some national parks may contain organisms which can maintain themselves without interference by man. But the plant and animal community organization of many others will change with time. As a result of natural forces, management may be necessary in such areas to preserve certain organisms. Such management might involve the control of fire, or the use of fire. Or it might involve any one of a number of possible procedures to alter an undesirable condition or trend. The prevention of severe overgrazing and overbrowsing by game animals is one such management measure. Contradictory as it may seem, it is our belief that *wild lands today will often require management in order to preserve their wilderness character.*

It would be tragic, however, if the necessity for management on some wild lands should deter efforts to set aside suitable natural areas for preservation. The difficulties involved must be recognized but also the benefits which can accrue through foresight and initiative must be kept in mind. Some of Uganda's most productive acres, in terms of national income, certainly could be her best game lands.

It is our hope that Uganda will undertake the preservation of its heritage of thrilling big game animals through adequate systems of national parks and hunting reserves. These areas have national and international values which should not be lost.

SUMMARY

The game resource in Uganda is a rich one and much of the country's character and considerable tourist income would be lost if further wildlife depletion occurs. Under African conditions, big game preservation requires areas of suitable game habitat set aside primarily for that purpose. Location, topography, history, land use pattern, tsetse fly influences, variety of animal life, African interests in wildlife preservation, and history of game management in Uganda are reviewed.

The present game reserve and sanctuary system seems nowadays to have several weaknesses. A system of managed hunting and game-ranching areas is suggested. These would have several important values. The national park system could benefit through control of overgrazing caused by game and through expansion to include presently unrepresented biotic areas. Serious erosion and range damage

caused especially by overabundant hippopotami in Queen Elizabeth National Park requires prompt and adequate control measures. Both National Park and Game Department officials are dedicated to their work and should be supported to the fullest.

In natural area preservation, the importance of planning safeguards against possible encroachments 50 to 100 years ahead is stressed. The viewpoint of unspoiled nature as a goal is recognized but overgrazing even by wild animals, unlike failures to harvest plant crops, results in habitat deterioration of a type difficult to reverse. Natural areas nowadays often are islands amidst lands devoted to other purposes, and their biotas are more susceptible to destruction than on widespread wild areas. Wild lands today may often require management in order to preserve their wilderness character.

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RESULTS OF DEER EXCLOSURE EXPERIMENTS IN THE OTTAWA NATIONAL FOREST

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The influence of browsing by deer upon forest reproduction and subsequent forest composition is a matter of concern wherever deer are numerous in timberlands. The cooperative management units on the Ottawa National Forest are no exception. These forest lands, covering some 3200 acres, have been managed cooperatively by the University of Michigan and the U. S. Forest Service since 1941 and demonstrate the effects of various silvicultural practices on a variety of sites and in several forest types.

By 1948 the influence of browsing on reproduction became conspicuous; and, after severe local damage had occurred, the desirability of measuring these effects by excluding the deer from certain spots was recognized. In 1949 fifteen 40-foot square exclosures were constructed, five in each of three different forest types where selective logging operations had been conducted.

Exclosures 1 to 5 were in a mixed conifer-hardwood seepage swamp; 6 to 10 inclusive in the northern hardwood-hemlock type; and 11 to 15 inclusive in the white pine type. All were located in openings resulting from partial cutting operations.

Each exclosure was surrounded by a woven wire fence 8 feet high. During a heavy windstorm in October 1949 the fences of every exclosure were broken by falling trees. It was impossible to repair this damage until the summer of 1950. Then, 3-strand, barbless-wire overhangs were added to the fences because they had not proved to be deer-proof during the previous season. After this no deer entered the exclosures. Thus only partial protection was accomplished during the first season and it was not until the summer of 1950 that protection within the exclosures was complete.

The snowshoe hares were not excluded but because the animals were at a population low between 1941 and 1956 they could not have materially affected the young trees.

DESCRIPTION OF EXCLOSURE LOCATIONS

The exclosures were intentionally located under a variety of conditions, and description of these situations seems essential to an understanding of observed results.

Prior to logging the seepage swamp located in Section 9 T 44 N R 38 W was occupied by overmature white cedar mixed with balsam fir, white and black spruce, some white pine, yellow birch, hemlock, and considerable quantities of red maple. The soil is a sandy loam with the water table within a few feet of the surface. It is an excellent site for white spruce, white pine, and balsam fir. This area was partially cut beginning in the winter of 1947-48. The operation was completed in 1949. Two seasons elapsed between logging and establishment of exclosures 1, 2, and 3; and one for exclosures 4 and 5. The crowns of adjacent maples extended over a part of exclosure number 5, the others 1 to 4 were practically unshaded.

The mixed northern hardwood-hemlock stand, located in Section 17, T 44 N R 38 W, grew on silt-loam soil. Hard maple and yellow birch, interspersed with groups of hemlock, were the predominant species, with scattered elm, basswood, black ash, white cedar, balsam fir, and white spruce. This compartment containing exclosures 6 to 10 was cut during the winter of 1946-47 and two seasons elapsed before exclusion of deer from the exclosures.

The white pine type, located in Section 30 T 46 N R 36 W, grew on a sandy loam soil of medium quality. Mixed with the white pine was some red pine. In a subsidiary position was balsam fir, white and black spruce, some jackpine, white birch, and red maple. The last species has been increasing rapidly, and, in the natural course of succession, would ultimately take over the area if permitted to do so. Cutting in Section 30 was begun in the winter of 1941-42. The objective was to favor white pine by cutting merchantable size balsam fir, spruce, birch, jackpine, and defective white pine preliminary to making a later reproduction cutting for white pine. This preliminary cutting was completed in 1953. As a result the period between logging and establishment of the exclosures was not the same for all the exclosures. Numbers 11, 12 and 14 were in compartments cut seven years before the exclosures were built, number 15 five years, and number 13, two years prior to construction.

History of the Deer Herd

The deer population varied in density in the three sections. On Section 30 they were numerous in 1940, when injury to white pine reproduction was conspicuous. Although no direct census could be made, some indication of deer abundance may be gained from a comparison of browsing severity near the exclosures with that in other places where the deer population is known. In 1940 they probably numbered more than fifty per square mile. In later years the herd became less numerous, probably not more than twenty-five or thirty, and browsing on young pines was inconsequential. Browsing on red maple, however, was moderately heavy but caused less retardation than might have been expected.

In contrast, on Sections 9 and 17, deer numbers were relatively few in 1940, but later increased. From the amount of browsing, it is judged that their number must have been less than twenty per square mile. By 1946, browsing on hemlock reproduction had become conspicuous on Section 17, basswood sprouts were universally browsed, and the effects of deer on other hardwood growth was noticeable. However, the injury was not, at that time, considered to be excessive and not until 1948 did severe damage become apparent. When the exclosures were built there were probably thirty to forty deer per square mile. In section 9 browsing was slightly heavier than in 17 but was not considered to be serious since fir and spruce, the desired species from the forestry viewpoint, were not being injured. The animals probably numbered close to fifty per square mile.

RECORDING EFFECTS OF BROWSING ON FOREST REPRODUCTION

After the exclosures were built a series of milacre samples was examined and the reproduction by species and size classes recorded. Nine were inside and ten outside each exclosure. In addition, in 1951, in order to gain some information on what might have been expected if the exclosures had been installed more promptly after logging, milacre size plots were scalped of vegetation and litter, 4 inside and eight outside each exclosure. All these were re-examined in 1957 to learn the result of protection from deer browsing. Unfortunately unfavorable weather, lack of seed, and the rapid invasion of the scalped plots by herbaceous vegetation limited establishment of seedlings on these scalped plots.

Later in the summer of 1957 a more complete record was made of trees which had by that time grown beyond reach of deer. Thirty-six milacres inside and the same number outside were examined and the number of milacres recorded on which each tree species had reached seven feet or more in height. In this paper the results of all examinations are expressed in terms of stocked milacres, one or more trees per milacre being considered full stocking.

Data collected on sample milacres first examined in 1949 and those scalped in 1951, show the changes in reproduction occurring between the time the plots were first established and 1957 when the final examination was made. They indicate the effects of browsing on the more sensitive species and the slower-growing conifers. In spots now fully stocked with maples few of the trees in the three-foot class or smaller will survive the maple shade. In other places, however, they will fill openings not occupied by larger trees.

EFFECTS OF BROWSING AS A WHOLE

In Table 1 is presented the results from all exclosures combined. That deer are having a profound effect on forest reproduction is clearly shown in this tabulation combining a wide variety of types and sites. Some species are being materially reduced in terms of effective stocking whereas others seem to suffer little. For example, although heavily browsed and retarded in growth, hard maple occupies approximately as many milacres outside as inside the exclosures. Red maple is a somewhat more favored browse species, but nevertheless its resistance to browsing effects maintains stocking outside almost equal to that inside. On the other hand, the stocking of birches and cherries is much higher inside than outside. Obviously the future stands will contain a large proportion of species resistant to browsing and the proportion of sensitive species will be greatly reduced.

Although the data in Table 1 are striking, the effects of browsing becomes more meaningful when the exclosures are considered by groups. The five plots in Section 30, although different in some respects, are more similar to one another than to other groups. Similarly those in Section 9 form a comparable group, as do those in Section 17.

SECTION 30 EXCLOSURES

In Section 30, deer browsing during the time that elapsed between cutting and their exclosure undoubtedly had an effect upon favored browse species such as the aspens and birch. These trees reproduce

TABLE 1. STOCKING OF ALL DEER EXCLOSURES WITH TREES SEVEN FEET AND TALLER. GRAND TOTALS FOR ALL SPECIES BY STOCKED MILACRES IN 1957. (540 UNITS INSIDE AND 540 OUTSIDE)

	Milacres Stocked—1957					
Species	Inside		Outside		Difference	
	No.	%	No.	%	No.	%
All species	379	70.2	227	42.0	152	28.1
Balsam fir	32	5.9	13	2.4	19	3.5
Hard maple	108	20.0	113	20.9	+5	0.9
Red maple	118	21.9	85	16.7	33	6.1
White birch	48	8.9	7	1.3	41	7.6
Yellow birch	75	13.9	13	2.4	62	11.5
Pincherry	77	14.3	8	1.5	69	12.8
Black cherry	18	3.3	10	1.9	8	1.5
Choke cherry	22	4.1	0	0.0	22	4.1
White spruce	0	0.0	1	0.2	+1	0.2
Black spruce	3	0.6	4	0.7	+1	0.2
Red pine	1	0.7	0	0.0	1	0.2
White pine	1	0.2	0	0.0	1	0.2
Mountain ash	1	0.2	0	0.0	1	0.2
Basswood	1	0.2	0	0.0	1	0.2
Elm	3	0.6	0	0.0	3	0.6

TABLE 2. SUMMARY OF STOCKING WITH TREES SEVEN FEET OR TALLER IN SECTION 30. (BASED ON 180 MILACRES INSIDE AND 180 OUTSIDE THE EXCLOSURES)

	Milacres stocked—1957					
Species	Inside		Outside		Difference	
	No.	%	No.	%	No.	%
All species	125	69.4	60	33.3	65	36.1
Red maple	65	36.1	37	20.6	28	15.5
White birch	46	25.6	7	3.9	39	21.7
Balsam fir	29	16.1	12	6.7	17	9.4
Black cherry	17	9.4	10	5.6	17	3.8
Pin cherry	5	2.8	0	0.0	5	2.8

best upon exposed mineral soil and are poor competitors. Therefore, if eliminated by deer prior to exclusion they would probably not invade the exclosures. White and red pine would almost certainly have been affected similarly, but other species such as balsam fir and red maple, not so severely influenced by browsing, would have suffered less. In evaluating the results from the exclosure experiments the length of time that the land was unprotected following logging should certainly be taken into account, it being highly probable that browsing prior to erection of the exclosures may have eliminated or reduced the reproduction of some species that had become established immediately following logging.

Table 2 summarizes the effective stocking with trees over 7 feet in height on the 5 exclosures in Section 30 in 1957.

It should be noted that almost 70 per cent of all units in the five exclosures in Section 30 are stocked with trees of some species over seven feet in height, whereas trees of that size are growing on only one-third of the milacres in the outside samples. In exclosures eleven and thirteen, almost 90 per cent of the 36 milacres inside the fence were stocked whereas outside the stocking was 25 and 56 per cent respectively. In both instances red maple, white birch and black cherry predominated. White pine, the species most desired, was present in the seven foot or taller class in insignificant numbers. It is interesting but not necessarily significant that the single white pine of this size within any exclosure was in number 13, the one built only two years after logging.

Stocking by trees in the smaller size classes is presented in Table 3. The stocking inside and outside the exclosure, when all species are taken together, is not significantly different. This is due to the predominance of maple reproduction, of which red predominates over hard maple. The birches present on the Section 30 enclosures are predominantly white birch as would naturally be expected in the pine type. This table brings out the fact that the proportion of milacre units stocked with seedlings in the small size classes is not greatly different inside and outside the exclosures; but the difference becomes greater in the larger size classes.

It is interesting to note that the percentage of milacres stocked with white spruce under three feet is considerably greater on the scalped than on the unscalped plots. In contrast, balsam fir stocking is higher on the unscalped units. There is very little difference between the stocking inside and outside for these two species since neither is sought by the deer. Outside the exclosures cherries in the larger sizes appear on very few units but are present in the smaller classes in fair numbers. This is because they are being held back by browsing but still survive.

SECTION 9 EXCLOSURES

The exclosures in Section 9, seepage swamp, with the exception of number 5, were all placed in clear-cut areas from which all merchantable trees had been cut, although some overhead shade was cast by residual unmerchantable trees. Exclosure 5 was located on a spot higher than the others and was partially covered by the branches of adjacent maples.

Table 4 compares the stocking with seven foot or taller trees within and without the five exclosures. As was the case in Section 30 there

TABLE 3. PERCENTAGE OF STOCKED MILACRES INSIDE AND OUTSIDE DEER EXCLOSURES. (40 UNSCALPED AND 20 SCALPED INSIDE, AND 50 UNSCALPED AND 40 SCALPED OUTSIDE)

Sec. 30 T 46 N R 36 W

		Original Examination						Re-examination					
		Inside Excl.			Outside Excl.			Inside Excl.			Outside Excl.		
		All	>6″	>3′	All	>6″	>3′	All	>6″	>3′	All	>6″	>3′
All species	s	0.0	0.0	0.0	0.0	0.0	0.0	95.0	65.0	5.0	87.5	67.5	5.0
	u	93.3	88.9	93.3	88.0	80.0	22.0	95.6	95.6	73.3	94.0	92.0	32.0
Balsam fir	s	0.0	0.0	0.0	0.0	0.0	0.0	20.0	5.0	0.0	7.5	2.5	0.0
	u	48.9	35.6	4.4	44.0	32.0	8.0	48.9	48.9	24.4	44.0	40.0	12.0
Hard maple	s	0.0	0.0	0.0	0.0	0.0	0.0	5.0	5.0	0.0	0.0	0.0	0.0
	u	2.2	2.2	0.0	6.0	6.0	0.0	6.7	6.7	2.5	16.0	16.0	0.0
Red maple	s	0.0	0.0	0.0	0.0	0.0	0.0	35.0	15.0	0.0	30.0	10.0	0.0
	u	55.6	40.0	4.0	44.0	42.0	8.0	71.0	68.9	40.0	64.0	60.0	20.0
Birches	s	0.0	0.0	0.0	0.0	0.0	0.0	35.0	15.0	0.0	30.0	10.0	0.0
	u	55.6	40.0	4.4	44.0	42.0	9.0	71.1	68.9	40.0	64.0	60.0	20.0
White spruce	s	0.0	0.0	0.0	0.0	0.0	0.0	80.0	40.0	0.0	60.0	40.0	0.0
	u	22.2	20.0	0.0	28.0	22.0	0.0	24.4	24.4	20.0	26.0	20.0	0.0
Aspens	s	0.0	0.0	0.0	0.0	0.0	0.0	30.0	20.0	5.0	20.0	12.5	2.5
	u	26.7	24.0	15.6	18.0	16.0	6.0	22.0	22.2	20.0	12.0	12.0	4.0
Cherries	s	0.0	0.0	0.0	0.0	0.0	0.0	40.0	25.0	0.0	40.0	17.5	0.0
	u	40.0	37.7	6.6	30.0	28.0	2.0	44.4	42.2	28.9	34.0	32.0	8.0

s = Scalped
u = Unscalped

Unscalped milacres established 1949.
Scalped milacres, 1951.

This difference accounts for the smaller size of reproduction on the scalped plots. Also grass and forbs filled in many of the scalped plots by the spring following scalping, thus inhibiting tree growth.

Black spruce, red oak, and white pine present in insignificant numbers.

TABLE 4. SUMMARY OF STOCKING WITH SEVEN FOOT OR TALLER TREES IN SECTION 9. (BASED ON 180 MILACRES INSIDE AND 180 OUTSIDE THE EXCLOSURES.)

Milacres stocked—1957

Species	Inside		Outside		Difference	
	No.	%	No.	%	No.	%
All species	101	56.1	55	30.6	46	25.5
Pin cherry	41	22.8	7	3.9	34	18.9
Hard maple	28	15.6	25	13.9	3	1.7
Red maple	22	12.2	24	13.3	+2	+0.4
*Choke cherry	15	8.3	0	0.0	15	8.3
Trembling aspen	10	5.6	0	0.0	10	5.6
Yellow birch	8	4.4	5	2.8	3	1.6
*Balsam fir	3	1.7	1	2.8	+2	+1.1
*White birch	2	1.1	0	0.0	2	1.1

Black spruce, Mountain ash, and Black cherry in insignificant numbers.
*Exclosure number 5 only.

was considerable variation between exclosures in degree of stocking and in species that have reached the seven-foot level. The average percentage of stocked milacres for the five exclosures in the seepage swamp was approximately 56 per cent inside and almost 31 per cent outside, the maximum stocking inside being almost 78 per cent and the minimum a little less than 42 per cent.

The differences in species composition within the five exclosures was chiefly due to the proximity of seed source, or to the character of the seed bed. For example, in exclosure 5, birds roosting on overhanging branches were responsible for planting choke cherry that occupied almost 42 per cent of the units within that exclosure. The seeds of both red maple and hard maple were numerous everywhere which accounts for their universal abundance. Although aspen and birch seed were evenly and widely disseminated, their strict requirements for germination and establishment prevented their reproduction.

Next to cherry, hard maple occurred on the greatest number of milacres followed by red maple. As in Section 30, the percentage of milacres stocked with maples at the 7-foot level differed insignificantly inside and outside the exclosures. Although browsing may delay the attainment of the seven foot class, it seldom prevents the ultimate success of maples except when the deer herd is far more numerous than they have been on the experimental areas. Birches were not numerous in Section 9 but the difference inside and outside the exclosures seems significant.

That stocking was similar inside and outside when the exclosures were installed is evident from the original examination. That seedlings of a variety of species continued to invade is also apparent from the presence both inside and outside of the small size classes. However, the effects of browsing are disclosed in the 3-foot and taller class, present on 35 per cent of the scalped plots inside and only on 7.5 per cent outside. On the unscalped plots 71.1 and 40.0 per cent respectively were stocked.

The relatively low stocking with balsam fir is not characteristic of the area as a whole and is due to inadequate seed source near the exclosures. The influence of mineral soil upon the establishment of birch reproduction is shown in the smaller sizes when the scalped and unscalped plots are compared, and its attractiveness as browse is shown by the absence of 3-foot tall or taller birches outside the exclosures.

SECTION 17 EXCLOSURES

Forest reproduction in the hardwood-hemlock type in Section 17, taken all together, has been more successful both inside and outside exclosures than in the other series, but the influence of deer on species composition is striking. The results are summarized in Table 6.

Eighty-five per cent of all milacres within the exclosures were stocked with trees seven feet or taller. The range was from 56 to 100 per cent, with only one under 80 per cent. This was the exclosure number 7 into which one or more deer jumped in and out during 1949. Therefore it received more intensive summer browsing during that season than the other exclosures. A deer jumped the fence of number 6 and died within it, after having browsed considerably. No other deer was known to have entered it. Stocking there was 80.6 per cent

TABLE 5. PERCENTAGE OF STOCKED MILACRES INSIDE AND OUTSIDE DEER EXCLOSURES (40 UNSCALPED AND 20 SCALPED INSIDE AND 50 UNSCALPED AND 40 SCALPED OUTSIDE)

Sec. 9 T 44 N, R 38 W

		Original Examination						Re-examination					
		Inside Excl.			Outside Excl.			Inside Excl.			Outside Excl.		
		All	>6″	>3′	All	>6″	>3′	All	>6″	>3′	All	>6″	>3′
All species	s	0.0	0.0	0.0	0.0	0.0	0.0	85.0	85.0	35.0	77.5	72.5	7.5
	u	91.1	77.8	8.9	95.0	82.5	0.0	86.7	84.4	71.1	87.5	80.0	40.0
Balsam fir	s	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.5	5.0	0.0
	u	6.7	2.2	0.0	27.5	2.5	0.0	11.1	11.1	4.4	20.0	17.5	2.5
Hard maple	s	0.0	0.0	0.0	0.0	0.0	0.0	50.0	35.0	5.0	35.0	17.5	0.0
	u	44.4	37.8	2.2	35.0	30.0	0.0	42.2	42.2	26.7	42.5	37.5	17.5
Red maple	s	0.0	0.0	0.0	0.0	0.0	0.0	35.0	30.0	5.0	50.0	37.5	2.5
	u	71.1	51.1	0.0	62.5	47.5	0.0	48.9	48.9	33.3	55.0	52.5	32.5
Birches	s	0.0	0.0	0.0	0.0	0.0	0.0	65.0	65.0	10.0	70.0	67.5	0.0
	u	17.8	2.2	0.0	40.0	12.5	0.0	20.0	17.8	13.3	22.5	15.0	0.0
White spruce	s	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.0	2.5	0.0
	u	2.2	0.0	0.0	10.0	0.0	0.0	4.4	4.4	0.0	5.0	5.0	0.0
Aspens	s	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.0	10.0	0.0
	u	6.7	2.2	0.0	15.0	10.0	0.0	6.7	6.7	4.4	2.5	2.5	2.5
Cherries	s	0.0	0.0	0.0	0.0	0.0	0.0	35.0	35.0	20.0	20.0	15.0	5.0
	u	20.0	20.0	6.7	7.5	2.5	0.0	42.2	42.2	42.2	10.0	7.5	0.0

s = Scalped
u = Unscalped

Unscalped milacres established 1949; scalped milacres 1951. This difference accounts for the smaller size of reproduction on the scalped plots. Also grass and forbs filled in many of the scalped plots by the spring following scalping, thus inhibiting tree growth.

TABLE 6. SUMMARY OF STOCKING WITH SEVEN FOOT OR TALLER TREES IN SECTION 17. (BASED ON 180 MILACRES INSIDE AND 180 OUTSIDE THE EXCLOSURES)

	Milacres Stocked					
Species	Inside		Outside		Difference	
	No.	%	No.	%	No.	%
All species	152	85.0	112	62.2	40	23.0
Hard maple	79	43.9	88	48.9	+9	+5.0
Yellow birch	67	37.2	8	4.4	59	32.8
Red maple	31	17.2	24	13.3	7	3.9
Elm	3	1.7	0	0.0	3	1.7
Pin cherry	31	17.2	1	0.6	30	16.6
Choke cherry	5	2.8	0	0.0	5	2.8

Basswood present in insignificant numbers.

as compared with 94.4, 94.4 and 100 per cent in exclosures 7, 8 and 9 respectively, but the lower stocking was probably due to shade rather than to browsing during 1949.

As would naturally be expected, hard maple, more often than any other species, had reached a height of seven feet or more. Furthermore, that species has been as successful in reaching the seven foot level outside the enclosure as inside. Nevertheless, it was much shorter outside, having endured 10 years of browsing before it could outstrip the deer. Inside, in the fall of 1952, it was higher than the fence after three years of protection, and by 1957 some trees were 15 feet or more in height. Considering the type as a whole, many patches of hard maple had not reached the seven foot level in 1957. As a rule, however, the maple had outgrown the deer by 1956. It is estimated that browsing lengthened the hard maple rotation by at least 5 years. Yellow birch, basswood, and American elm, all important species in the original forest were reduced by browsing to an insignificant position as potential components of the next tree generation.

The summary of observations on the lower size classes of seedlings are presented in Table 7. All milacres were stocked with small seedlings and 91 per cent with seedlings over 3 feet in height. The small trees are mostly overtopped and will die from suppression except for those few that are growing in openings.

DIFFERENTIAL EFFECTS OF BROWSING

From the information summarized in tables 1 to 7 inclusive, it is evident that the browsing by deer affects the different tree species or groups of species differently. When this information is supplemented by observations on the deer's browsing proclivities on other species that do not occur frequently in or near the exclosures some general conclusions may be drawn concerning the differential effects that will result in modifying forest composition.

Some species are browsed very little by deer, for example white spruce. Others, such as yellow birch, basswood, hemlock, white cedar and aspens, are highly palatable and eagerly sought. All these species have been greatly reduced or eliminated outside the exclosures. Some species are browsed upon heavily but, unless all shoots are browsed annually, are able to repair the injury so effectively that they may recover and grow out of reach even though they may be held back for a number of years, for instance hard maple and red maple.

The length of retardation will be directly proportional to the severity of browsing. Sometimes mortality may result even in the case of the species most resistant to browsing. For example, on one area on the Ottawa Forest which has been under intensive observation for 18 years, red and hard maple have been killed entirely; and on another, observed for 17 years, red maple has been almost elminated and is gradually being replaced by the less palatable balsam fir and white spruce.

Severe browsing on balsam fir or black spruce is sometimes observed. When this occurs it indicates either an excessively high deer population or a local concentration of browsing, as along frequently-used trails or in or near winter shelter where deer congregate. Such concentrations did not occur around the exclosures, even though the deer did tend to walk around and around the fences, browsing more heavily

TABLE 7. PERCENTAGE OF STOCKED MILACRES INSIDE AND OUTSIDE DEER EXCLOSURES (40 UNSCALPED AND 20 SCALPED INSIDE, AND 50 UNSCALPED AND 40 SCALPED OUTSIDE)

Sec. 17 T 44 N R 38 W

		Original Examination						Re-examination					
		Inside Excl.			Outside Excl.			Inside Excl.			Outside Excl.		
		All	>6″	>3′	All	>6″	>3′	All	>6″	>3′	All	>6″	>3′
	s	0.0	0.0	0.0	0.0	0.0	0.0	100.0	90.0	50.0	100.0	94.9	10.3
All species	u	100.0	91.0	40.0	100.0	90.0	20.0	100.0	100.0	91.1	100.0	100.0	86.0
	s	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Balsam fir	u	13.3	4.4	2.2	4.0	0.0	0.0	8.9	8.9	0.0	2.0	2.0	0.0
	s	0.0	0.0	0.0	0.0	0.0	0.0	95.0	60.0	25.0	84.6	46.2	7.7
Hard maple	u	77.8	60.0	28.9	82.0	60.0	16.0	86.7	75.6	57.8	90.0	80.0	64.0
	s	0.0	0.0	0.0	0.0	0.0	0.0	50.0	40.0	0.0	66.7	59.0	2.6
Red maple	u	48.9	37.8	4.4	52.0	34.0	0.0	35.6	33.3	26.7	46.0	46.0	32.0
	s	0.0	0.0	0.0	0.0	0.0	0.0	75.0	55.0	5.0	76.9	61.5	0.0
Birches	u	71.1	53.3	2.2	76.0	44.0	2.0	55.6	55.6	46.7	58.0	54.0	14.0
	s	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.1	5.1	0.0
Aspens	u	17.8	11.1	2.2	22.0	0.0	0.0	4.4	4.4	4.4	2.0	2.0	0.0
	s	0.0	0.0	0.0	0.0	0.0	0.0	30.0	25.0	20.0	17.9	10.3	0.0
Cherries	u	17.8	17.8	4.4	12.0	2.0	2.0	25.6	26.6	26.6	12.0	12.0	2.0
	s	0.0	0.0	0.0	0.0	0.0	0.0	10.0	5.0	0.0	12.8	7.7	0.0
Hemlock	u	22.2	0.0	0.0	22.0	4.0	0.0	8.9	6.7	0.0	10.0	6.0	4.0

s = Scalped
u = Unscalped

Unscalped milacres established 1949, scalped milacres, 1951.
This difference accounts for the smaller size of reproduction on the scalped plots. Also grass and forbs filled in many of the scalped plots by the spring following scalping, thus inhibiting tree growth.

next the fence than elsewhere. This habit was considered in laying out the sampling areas outside the fences.

Pines are readily browsed by deer. When this occurs they are severely injured, but judging from our general observations, the larger seedlings of these species were not excessively browsed in the places where the exclosures were located. Too few seedlings became established and grew either within or adjacent to the exclosures to provide direct evidence of browsing effects. However, we know from other sampling, soon after logging, that pine seedlings should have been more abundant than they were in Section 30 where an abundant seed source was available. Our tentative conclusion from this indirect evidence is that before the exclosures were installed deer had destroyed the young pine seedlings. Later the seed that fell in the exclosures failed to produce established seedlings because of competition with other vegetation that had by then covered the ground. This conclusion seems logical but is supported only by general observations, since only in a single instance was a small white pine seedling on one of the sampling units actually observed to have been eaten by a deer.

In the case of white cedar, hemlock, elm, aspens, and yellow birch observations show positively that reproduction was abundant in the locations of the exclosures wherever mineral soil was exposed and a seed source was present. All these species were sought by deer in the small seedling stage and browsed close to the ground during the summer.

Basswood seedlings were nowhere abundant but only those that started in spots where logging slash or other obstructions protected them from the deer did they survive during the year following logging. By 1957 the hard maple in Section 17 generally had grown above reach of the deer and in these young maple stands the deer passed through on trails but were not tempted to pause and browse. Basswood seedlings were appearing in considerable numbers, but whether they will be successful in competing with the overtopping maple is doubtful.

Effect on the Future Forest and the Deer

The effect of deer browsing on forest composition in the next tree generation will not be the same on all three sections. In Section 30 the trend will definitely be in the direction of red maple. However, balsam fir reproduction and to a lesser degree white spruce and white pine are gradually increasing in quantity. The browsing has retarded the height growth of the red maple and cherries, relatively unsuitable species, and has favored the conifers except, perhaps, the very small seedlings. Therefore, on Section 30 the results indicate that at the population levels prevailing between 1949 and 1957 deer browsing has favored conifers, particularly balsam fir and white spruce. White birch and aspen have been almost eliminated.

In Section 9 the deer population is heavier and the maples have been more retarded than on either Section 30 or Section 17. Although about half the milacre samples outside the exclosures are stocked with small size maples, on less than 15 per cent have the trees grown beyond reach of deer. The low percentage of the larger maples within the exclosures presented in Table 4 is misleading because in several exclosures cherries have taken over, occupying a large part of the space within the exclosure where more valuable trees might grow. Balsam fir will ultimately make up a considerable part of the future stand, and white spruce is slowly on the increase, both outside and inside the exclosures. It is interesting to note that stocking with balsam fir is higher outside than inside the exclosures, due possibly to greater competition with broadleaved trees inside. Thus on Section 9 the high deer population is retarding the hardwoods and favoring some of the conifers. Other hardwoods such as the birches and aspens have been prevented from attaining a height above the deer's reach. With the upswing of the hare population it seems likely that these trees will make up a very small part of the next generation in Section 9, the next tree generation being a mixture of balsam fir, maples, and white spruce, a productive type desirable both for deer and wood production; providing deer with both food and cover and the logger with pulpwood and sawlogs.

In the hardwood-hemlock type the influence of deer browsing on the future forest composition is most striking. Hard maple and to a lesser degree red maple are the only species that have been able to overcome the effects of browsing. Yellow birch, which originally made up at least 30 per cent of the stand will be reduced to less than 5 per cent, elm less than 2 per cent. Basswood and hemlock were completely eliminated during the period between 1949 and 1957, but because of their great tolerance it is possible that they may be able to invade the young maple stand later.

It is certain, however, that the next stand will be almost pure maple, predominantly hard maple. There will be virtually no winter cover for deer and very little food during either summer or winter for the animals. A sharp reduction of deer numbers seems inevitable.

The consequences of overbrowsing in the mixed northern hardwood-hemlock type will be disastrous for the deer and from the viewpoint of the forest little less so. The development of pure maple stands over large areas will inevitably lead to decadence of the stands through the action of injurious organisms; insects or other animals, fungi or other micro-organisms that are favored by single species stands. The selective nature of deer browsing favors such species as balsam fir and white spruce, and moderate browsing is not likely to affect pines deleteriously. Excessive browsing on pines, can, however, be disastrous.

Browsing effects provide an excellent index to deer populations and could well be used, if evaluated properly, to indicate how the herd should be handled in the interest of both wood and deer production. It is evident however, from this study that the same number of deer per square mile may in one instance cause undesirable changes in forest composition whereas in another it may produce desirable effects. The important consideration is the severity of browsing on desired tree species rather than the absolute deer numbers per unit of area.

One conclusion is inescapable. The regulation of the deer herd in the best interest of man is a complex problem that cannot be solved by uniform state-wide or even county-wide regulation. The problems of deer management are very local matters, requiring sharp reduction of the herd in one place and its increase in another. Some foresters have said there is no compatibility between the production of deer and wood. Some wildlife managers reply "So what?"

Studies such as the one herein described demonstrate the two are not only compatible, but that the presence of deer can in some areas retard development of undesirable tree species, maintaining desirable mixtures for the multiple production of deer and wood. Under other conditions, however, an even lower population may create conditions undesirable in every respect.

Thus we see that deer are an integral part of the forest community that can only be handled intelligently on the local level.

ELK AND ELK HUNTING IN IDAHO

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The Rocky Mountain elk (*Cervus canadensis nelsoni*) is indigenous to the State of Idaho and presently found in at least 40 of the 44 counties of the State. Only the agricultural areas bordering the Snake River on the north side are outside the present elk range. Elk have been extending their range for the past 30 years and today Idaho provides elk hunting for about 50,000 residents and over 4,000 non-residents, of which one half are from California.

Early History and Population Trends

The Snake River plains of southern Idaho became the route of the Oregon trail as well as the route of the first explorers and thousands of immigrants depended upon the native big animals for food. Elk were common in the foothills bordering the Snake River plains when the explorers of the 1810's and the fur trappers of the 1820's traversed this country. The swelling tide of immigration had almost eliminated elk bordering the Snake River plains by 1870 (McConnell, 1957).

Lewis and Clark in their exploration from St. Louis to the Pacific coast in 1804-1806 (Thwaites, 1904) actually spent about 30 days in what is now northern Idaho. On the western trip not a single mention was made of elk, though the hunters of the expedition were hunting constantly. On the return trip Captain Lewis recorded on June 27, 1806, while camped on the Lolo trail:

''The Indians inform us that there is great abundance of elk in the valley about the Fishery on the Kooskooske River.'' There is good reason for the scarcity of elk along the high Lolo trail even though the Indians reported them common at the lower elevations. The high country along the Lolo trail led through almost impenetrable tangles of down timber. Captain Lewis commented on the difficulty of getting horses over and through such timber during the journey west.

Even though elk might have been found down near the Lochsa

[1]The University of Idaho, The Idaho Department of Fish and Game, The U. S. Fish and Wildlife Service and The Wildlife Management Institute Cooperating.

River, the men and horses of the Lewis and Clark expedition were in poor condition and there were good chances of losing horses as well as men in the steep and rugged canyons of this area.

Central and northern Idaho forests have been subjected to fires throughout the period of Indian occupancy (Leiberg, 1900). Most of these fires were scattered in the spruce-fir zone in the summer elk range, rather than in the lower winter ranges. Throughout central and northern Idaho there was much mining activity beginning in 1860 with the discovery of gold at Pierce. Isolated mining towns such as Florence and Leesburg supported several thousand people. These back country mining towns together with the unending stream of prospectors resulted in a steady drain of the big game resources (McCulloch, 1953).

The early biennial reports of the Idaho Fish and Game Department contained little information concerning elk. In order to quickly review the period from 1900 to 1957 we have divided the time into three periods.

1900-1912: In 1900 elk were reported as becoming "scarcer every year," yet in 1909 (2nd Biennial Report, Idaho Fish and Game Department) the State Game Warden reported elk as "frequently found in Idaho, Custer, Lemhi, and Bingham counties, and also in the counties along the Idaho-Wyoming line." The State Game Warden complained that elk were being killed only for their "tusks."

The growing scarcity of elk north of the Salmon River resulted in a closure of the elk hunting season in 1911 in 9 of the 10 counties in this section of the State. This was the year following the fires in northern Idaho which covered nearly 3,000 square miles. The first efforts at elk restoration were seen in 1909 when the State Legislature created the game preserve on the South Fork of the Payette River, a game preserve destined to far outlive its usefulness and still on the statute books.

1913-1926: A marked increase was recorded in 1913-14 and although the Chamberlain Basin herd, called then the State's largest herd, was estimated 610, faster increase was desired. That elk were being fed during the winter is shown by a photograph in the Fourth Biennial Report (1913) of a herd of approximately 300 elk with the caption "An elks' convention in Idaho." In the mid-twenties estimates of populations were around 5,000 elk and at least 6,000 were estimated in 1926.

Table 1 is an incomplete list of the elk known to have been transplanted from 1916-1946. The 1917-1918 Biennial Report mentioned that 200 elk were shipped into the State and released in Adams, Idaho,

TABLE 1. ELK RELEASED IN IDAHO (1916-1946)

Year	No.	Location	Source of Elk
1915	65	Arrowrock Dam, Boise and Elmore Counties	....
1916	17	Pocatello, Bannock County	Yellowstone National Park
1917	18	Pocatello, Bannock County	Yellowstone National Park
1919	21	Boyhill Creek, Shoshone County	Yellowstone National Park
1925 or 26	58	Grizzly Flats, Kootenai County	Yellowstone National Park
1935	19	Hope, Bonner County	Yellowstone National Park
1936	41	Grizzly Flats, Kootenai County	Yellowstone National Park
1936	17	Hope, Bonner County	Yellowstone National Park
1937	15	Hope, Bonner County	Yellowstone National Park
1938	60	Herrick, Shoshone County	Yellowstone National Park
1939	74	Near Kellogg, Shoshone County	Yellowstone National Park
1944	50	Owyhee County	Jackson Hole, Wyoming
1946	56	Owyhee County	Yellowstone National Park
1946	19	Owyhee County	Pocatello, Idaho
1946	40	Pocatello, Bannock County	....

Bannock, Boise, and Elmore counties. Rasmussen (1949) lists a total of 675 elk as having been transplanted to Idaho from Yellowstone National Park.

1927-1957: In the last 30 years there has been a noticeable increase in elk and in 1927-28 (Twelfth Biennial Report, Idaho Fish and Game Department) it was noted that game animals, particularly elk, were taxing the capacity of some winter ranges. Population estimates ranged from 10,000 in 1931-32 to 29,000 in 1941 to over 60,000 since 1954. Although there have been no large forest fires in northern Idaho since 1934, the increased acreages of logged areas are providing favorable elk habitat. A gradual decrease in elk population can be expected in the Clearwater River and St. Joe River drainages where the coniferous forest cover is beginning to return after the largest fires of 1910, 1919, and 1934.

The spread and increase of elk in vast areas north and south of the Clearwater River drainage has been a striking phenomenon of more recent years. Even in the years since 1950 it has been an annual event for hunters to find elk occupying areas in which they were not found in previous recent years.

ELK HABITAT TYPES

Elk in Idaho are adapted to a wide variety of types of vegetation, topography, and climate. The elk elevational range varies from 1,100 feet to 11,500 feet with the majority of their winter range from 2,000 feet to 5,500 feet.

Annual precipitation varies from approximately 15 inches in the more arid parts of southern Idaho elk range to over 65 inches in the higher mountains of northern Idaho with two-thirds of this precipitation being in the form of snow.

Three of the major geographical areas of divergent habitat types are discussed in the following paragraphs.

Southeastern Idaho

Summer range in the higher mountains consists of Douglas fir (*Pseudotsuga menesiesii*), Lodgepole pine (*Pinus contorta*) as the major coniferous species with subalpine fir (*Abies lasiocarpa*), and Engelmann spruce (*Picea Engelmanni*). Aspen (*Populus tremuloides*) occupies a prominent place over much of this area and occurs in dense stands in the intermediate range. Elk wintering in the lower mountains feed largely upon box wood (*Pachistima myrsinites*), mountain maple, (*Acer glabrum*) and chokecherry (*Prunus virginiana demissa*). Interspersed in the drier sites are extensive areas of sagebrush-grass zone with sagebrush (*Artemisia* spp.), bitterbrush (*Purshia tridentata*), serviceberry (*Sorbus* sp.), snowberry (*Symphoricarpos* sp.) as principal shrubs, along with juniper (*Juniperus scopulorum* and *J. osteosperma*). Mountain mahogany (*Cercocarpus ledifolius*) is often present on steep, rocky sites and is an important winter food of elk whenever present. On portions of their range elk move only a few miles, often on the same mountain. There is one well-known migration, however, in Fremont County where elk move from the higher timbered areas within the Targhee National Forest over 30 miles to the southwest out across the sagebrush-grass zone of the upper Snake River plain and winter in areas of sagebrush, bitterbrush, and chokecherry at about 5,500 feet elevation.

Southwestern Idaho (Owyhee County)

Elk were introduced to the mountainous western portion of Owyhee County in 1944 and 1946, a county of 7,648 square miles and less than 7,000 people. The elk range in this portion of the State varies from sagebrush-grass, to open stands of juniper, mountain mahogany and in the higher elevations small stands of aspen, douglas fir, lodgepole pine and subalpine fir in the highest areas. Wintering areas are on the south facing slopes having ample stands of bitterbrush and mountain mahogany. Owyhee County's extensive range lands are among the most isolated portions of the State and accessible largely only in summer and fall.

Central and Northern Idaho

It is this portion of the State, particularly the centrally located counties, that supports the largest segment of the elk herd in Idaho. In the Clearwater River drainage system are to be found in excess of 25,000 elk. The topography varies from the most rugged, precipitous mountains to interior plateau lands such as Chamberlain Basin. In this portion of the State the elk is the principal big game animal, exceeding white-tailed and mule deer numbers. Elk occupy all of the four forest zones (Daubenmire, 1952). The spruce-fir zone, the highest belt of forest, provides a large share of the summer range, along with the cedar-hemlock and upper portions of the Douglas fir zone. Winter range is generally in the ponderosa and much of the Douglas fir zones.

The choice elk habitat in the Clearwater River drainage includes the areas of the large burns of 1910, 1919, and 1934. The 1910 fire, alone, burned nearly 3,000 square miles. Some of these fires burned from the bottom of major streams to the tops of the mountains. The resulting seral stages of shrubby growth provided an almost unlimited source of food. Today elk are largely found associated with these extensive shrub areas.

The Changing Habitat

The great fires of 1910, 1919, and 1934 covering more than 3,500 square miles in central and northern Idaho (Spencer, 1956) changed a habitat that supported relatively few elk to a habitat of greatly expanded potentialities. The earlier fires in the 18th and 19th centuries burned considerable summer range, but the 20th century fires burned large blocks of timber destined to become extensive winter range areas for elk. Mountain slopes formerly in timber became, in a few years, solid stands of shrubs.

The mature forests were reduced to the early stages of plant succession and the seral shrub stages occupied hundreds of square miles. Highly palatable shrubs as willow, red stem ceanothus (*Ceanothus sanguineus*), mountain maple, serviceberry, and chokecherry, provided an almost unlimited food supply (McCulloch, 1953). In a few areas of the 1910 and 1919 burns, there were evidences that by 1935, the elk herds had increased beyond the capacity of the shrubfields to support the winter concentrations. This was especially true in the upper Selway River drainage, an area heavily burned in both 1910 and 1919. On many favorable timber growing sites, dense stands of young timber are now replacing the former stands of shrubs. On the drier sites shrubs are still dominant. Failure of heavily burned sites to regenerate a satisfactory cover of any kind is resulting in serious local erosion in the loose granitic soils. Elk are definitely contributing to this erosion on the winter ranges. In many areas the luxuriant growth of willow and mountain maple has outgrown the reach of elk and further reduced the winter carrying capacity. Clearcutting such stands results in enormous increase of the food (U. S. Forest Service, Region One, 1957).

Patterns of block clearcutting in mature timber will improve winter habitat conditions for elk and stimulate a maximum of shrub growth for food. Following logging a maximum of shrub production is reached in 15 to 20 years (Pengelly, 1954). As the less desirable habitat developed in the higher country, there has been a noticeable drift into the lower country logged-over areas.

The timbered areas of central and northern Idaho will continue to produce the majority of elk. They are removed from centers of permanent human occupancy. As the extensive shrub fields are taken over again by coniferous reproduction, a lowering of the capacity to grow elk is inevitable.

INVENTORY METHODS

Two methods are currently in use to obtain a numerical trend, aerial and ground counts.

1. *Aerial Counts:* Some of the earliest aerial counting was made on the Pocatello Game Preserve in 1932, by Orange Olson of the U. S. Forest Service. Since 1949, annual flights have been made on selected parts of elk winter range, in southern, central, and northern Idaho.

The most favorable time to conduct trend flights is usually during late February and early March. With the passing of the major snowstorms there are usually periods of clear, moderate weather. The late storms obliterate all of the old tracks and with the elk moving out onto the exposed ridges they are easily observed. Recent population trends as determined by helicopter vs. straight-winged aircraft indicate (Norberg *et al.*, 1956) that under the most favorable conditions for airplane the helicopter count was 51.5 per cent greater.

2. *Ground Counts:* The most extensively used ground count trend method involves covering the principal wintering areas on foot, snowshoes, horseback, or by snow tractor. In this manner the tributary streams, ridges, and slopes are covered during late February, March, and sometimes to mid-April.

HUNTING

Despite the high estimated elk population in the 1930's hunting was permitted on only limited areas. Beginning in the early 1940's hunting areas were enlarged almost annually. In 1948, 27.5 per cent of the State was open to general elk hunting. There has been a steady increase in the amount of area open to elk hunting since 1948 and in the fall of 1957, 66.6 per cent of the State could be hunted for elk. The main changes from 1953 to 1957, following several years of inten-tensive population surveys and careful study of harvest records, permitted additional areas to be opened to general hunting rather than special hunts. By 1957 only the Snake River plains and the mountainous terrain in south central Idaho bordering Utah and Nevada were without an elk season.

The percentage of the State covered only by special elk hunts was at a high point for several years in the 1930's and 1940's and has now declined from a recorded 29 per cent in 1948 to 7.7 per cent in 1957.

Hunting seasons vary in length according to local conditions. Extremes in 1957 were 3 days and 92 days. More than half the open area in 1957 had a season of at least 30 days.

Idaho has never had a buck law, or a bull elk law, other than limited local regulatory restrictions, so practically all of Idaho's elk hunting has been for either sex,—a hunter's choice. This system is popular with Idaho hunters and they have seen the results in terms of fine trophies to cherish, excellent meat for the locker and a remarkably close sex ratio in the harvest in all but the most heavily hunted areas. The proportion of big racks taken, and the percentage of older animals in samples aged by technicians indicates that herds in many areas are only moderately hunted. Devising seasons and hunting procedures which will permit an adequate harvest of elk from heavily stocked ranges is an annual problem in several remote areas in Idaho.

THE HARVEST

As new areas were opened to hunting, more people hunted elk and the total kill climbed rather steadily (Table 2). Elk tag sales totalled only 7,348 in 1940, but increased to 12,752 in 1945; 19,826 in 1946; and 33,855 in 1950. Tag sales continued to gain nearly every year since 1946 and in each of the years 1955, 1956, and 1957 over 50,000 elk tags were sold. It is of interest to note that non-residents have never taken over 12 per cent of the total annual harvest even though no limits have been imposed upon the number of licenses or tags available. However, hunter success for the four years 1953-1956 has averaged about 48 per cent for non-residents compared to about 28 per

TABLE 2. ELK HARVEST IN IDAHO, 1937-1957 INCLUSIVE[1]

Year	Elk Tags Sold	Harvest	Year	Elk Tags Sold	Harvest
1937	6,072	2,133	1948	24,731	5,944
1938	6,409	2,298	1949	31,262	5,395
1939	7,284	........[2]	1950	33,855	7,165
1940	7,348	........[2]	1951	33,836	7,492
1941	10,796	........[2]	1952	43,217	8,792
1942	10,550	........[2]	1953	47,499	12,364
7943	12,055	2,398	1954	48,201	12,451
1944	11,036	2,874	1955	50,757	15,799
1945	12,752	4,392	1956	52,627	15,910
1946	19,826	5,435	1957	51,707	15,600
1947	27,361	6,549			

[1]Harvest figures for 1952 and earlier include estimates and, in some cases, various local checks; figures for 1953-1956, inclusive, are computed kills based upon the statewide game kill questionnaire; the 1957 figure is preliminary and is based upon incomplete examinations of hunter report cards and questionnaire.

[2]Information unavailable.

TABLE 3. SEX RATIO OF ELK KILLED DURING HUNTING SEASONS 1950-1957 INCLUSIVE

Year	Bulls	Cows
1950	283	233
1951	465	486
1952	305	309
1953	6,002	6,362
1954	6,436	6,015
1955	7,919	7,880
1956	7,561	8,349
1957[1]	3,115	3,004
Totals	32,086	32,638

[1]Incomplete returns, hunter report cards.

cent for residents. The number of non-resident big game license buyers was less than 2 per cent of total elk tag sales in 1944 and earlier. It averaged about 4 per cent for the years 1945-1952, and slightly over 7 per cent during 1953-1956. The 4,866 non-resident licenses sold in 1957 is the largest number of big game licenses sold in any single year.

North central counties, particularly Idaho, Clearwater, and Shoshone counties yield the largest part of the annual kill. During the years 1943 through 1953 the harvest here varied from 40 to 90 per cent of the total kill. During the period of 1953 through 1956 the Clearwater River drainage, which includes most of Idaho and Clearwater counties, yielded about 40 per cent of the annual kill or between 5,000 and 6,000 elk in each of the four years. The 1957 kill for these two counties was approximately 50 per cent of the total harvest.

The hunters' choice has resulted in a remarkably uniform sex ratio in the elk kill year after year. Table 3 shows the sex ratio taken from checking station records on special hunts and hunters questionnaires 1953-1956, and as reported by individual hunter report cards in 1957.

HUNTER SUCCESS

Hunter success has varied considerably in various hunts, depending upon accessibility and other factors. Special hunts, involving limited numbers of hunters, have varied from the 16 per cent hunter success in the Salmon River Game Preserve in 1949 to the 89 per cent in the Pocatello hunt in 1949 and the Selway Game Preserve hunt in 1947.

Eight special hunts in 1949 averaged 44 per cent hunter success in taking 573 elk; in 1950 eleven special hunts averaged 52 per cent hunter success in taking 747 elk; in 1955 eight special hunts averaged 49 per cent hunter success in taking 696 elk.

In general season hunts, success has varied from 11 per cent among 1,413 hunters checked through a Salmon River checking station in 1946, to 55 per cent in the Powell area in 1941. This latter area showed an annual hunter success from 36 per cent to 55 per cent in the six years 1937 through 1942 when from 743 to 1,224 hunters were checked in individual years.

Hunter success remains high in modern times. The random post-season questionnaire for 1956 indicated 27 per cent success for residents and 53 per cent for non-residents. For the 1957 season 16,120 elk hunters returning report cards showed hunter success of 38 per cent. Some of the major areas run in the neighborhood of 40 per cent hunter success year after year.

One of the major problems in Idaho elk management is the matter of getting capable, properly-equipped hunters into the more inaccessible elk ranges in sufficient numbers to make adequate harvests. To encourage hunter participation general hunts have replaced special hunts in recent seasons wherever possible. However, restrictions in the future may be necessary in certain areas.

The opening day elk kill is an important segment of the total season's kill and especially important in readily accessible areas.

In 1957, 17 counties out of 36 having an open season accounted for 95 per cent of the harvest. Opening day percentages of the total kill varied from 9 to 65 for counties having a single opening date, averaging 30. For counties having two opening dates, the first date percentages varied from 1 to 38, averaging 19, and the second period opening date, 8 to 21, averaging 12. Opening day is a special day for many hunters. A breakdown of hunting data by weeks, however, shows that after the seasonal peak in the first week there is a steady decline for the remainder of the season, with minor exceptions.

SUMMARY

Elk are found in at least 40 of the 44 counties in Idaho. Following the discovery of gold in 1860 elk populations were considerably reduced in the latter part of the 19th century. A population of 6,000 elk was estimated by 1926 which has grown to over 60,000 by 1954. Over 600 elk have been released in Idaho from 1915 to 1946, the parent stock coming mostly from Yellowstone National Park and Jackson Hole areas.

Elk occupy such habitat types as spruce-fir, cedar-hemlock, Douglas fir, ponderosa pine forest zones, and sagebrush-grass zones. Most winter range is at elevations of 2,000 to 5,500 feet, and in one area a herd moves across the sagebrush-grass zone to winter in sagebrush, bitterbrush and chokecherry. High elk populations built up in the extensive shrub areas which developed after the large fires in 1910, 1919, and 1934.

Population trends from year to year are determined by aerial and ground counts.

Elk hunting in Idaho is a hunters' choice of either sex. Records from 64,724 bagged elk show that females made up 50.4 per cent of the kill. Hunter success has averaged nearly 30 per cent in recent years and has exceeded 50 per cent in a few areas. During the last three years the sale of elk tags has exceeded 50,000, and the computed total kill has been in excess of 12,000 for the last five years.

The seasonal peak in the kill occurs in the opening week of the hunting season. Getting an adequate harvest in remote areas is a major management problem and general hunts have replaced many special hunts to encourage greater hunter participation.

ACKNOWLEDGMENTS

Appreciation is expressed to Vernon B. Rich, Federal Aid Coordinator, Idaho Fish and Game Department, for his part in acquiring information used in this report. Much of the information shown here resulted from various Federal Aid in Wildlife Restoration projects, particularly Project 85-R, Idaho Game Population Census and Range Study.

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DISCUSSION

MR. SETH GORDON [California]: Does logging and the intervals between the rows affect the hunting?

MR. FRED JOHNSON [U. S. Forest Service]: The parallel lines are from three to four hundred feet apart and we call that "strip" logging. The logging is done from a side road and the trees are skidded one hundred to three hundred feet.

MR. GORDON: How bad is your erosion there?

MR. JOHNSON: We think that we are doing a good job of erosion control mainly due to good engineering and the draining of the roads. If the roads are steep, of course, we get erosion, but most of the roads are flat. As long as we can get the water into areas between the roads, there is little erosion.

CHAIRMAN JONES: The speaker mentioned in his paper that about half of the out-of-state hunters were from California and that they did not take a very big percentage of the total. However, he did mention that the other out-of-state hunters had a much better success ratio and so I wonder if he would comment on that.

MR. MOHLER: Of course, there are some hunters who, no matter what they hunt, do not give themselves a chance. I think that the answer is one of equipment. The better hunters go properly equipped and, of course, they score just as well as our California friends. Adequate preparation is the main answer.

SEX DETERMINATION IN DRESSED ELK CARCASSES

RICHARD N. DENNEY
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The harvest, or the protection, of females is becoming increasingly recognized as the most effective method of controlling big-game populations. Increasing use of this principle in management has emphasized the importance of sex recognition in the field by law enforcement officers policing an ever-growing, and perhaps an ever more-inexperienced, army of big-game hunters.

In efforts to implement regulations pertaining to sex in deer, elk, antelope, and other species, game and fish departments require that evidence of sex be retained with dressed carcasses, whether quartered, hog-dressed, or otherwise handled. Such evidence generally consists of the antlers, head, hide, or sex organs, the last, wholly or in part.

In dressing out and transporting hundreds of thousands of big-game carcasses each season, it is inevitable that evidence of sex be lost or misplaced. This propensity in human-kind injects, in effect, a weakness into the law; or more exactly, the lack of a technique for quick and authoritative identification of dressed game carcasses, regardless of circumstance, leaves the enforcement officer without ready recourse in many doubtful cases. The opportunity thus provided to deliberate violators needs no further definition.

TABLE 1. CONJUGATE DIAMETERS OF COLORADO ELK AS DETERMINED BY MEASUREMENT OF CARCASSES AT CHECK STATIONS, 1956-57

	Bulls			Cows		
Check Station	Number	Range, Inches	Average Inches	Number	Range, Inches	Average, Inches
Rifle[1]	185	4.00-6.75	5.60	120	5.50-7.88	6.70
Idaho Springs[2]	182	4.50-7.00	5.75	87	5.12-8.00	6.90
Monarch Pass	33	4.62-7.00	5.90	25	5.50-7.50	6.80
Del Norte	264	3.75-7.25	5.80	132	5.25-8.00	6.80
Animas	83	4.12-7.00	5.72	65	5.25-8.25	6.69
Totals	747	3.75-7.25	5.77	429	5.12-8.25	6.78

[1]Includes 89 measurements from initial study in 1956.
[2]Includes 12 measurements from Ted's Place check station.

The lack of identification and a technique to determine sex has been given considerable attention since 1952, and intensive study since 1955, by the Colorado Department of Game and Fish. The present paper describes a process by which dressed carcasses of elk, quartered or whole, may be identified as to sex, with a minimum of 95 per cent reliability, in the absence of all external sex characters. The same technique, with appropriate adaptations, would almost certainly be applicable to all big-game species, since it makes use of prominent internal structures not easily destroyed in any process normally used in dressing and handling game in the field.

MATERIALS AND METHODS

Check Station Organization.—Prior to the 1957 elk-hunting season in Colorado, one or two Game Management and Federal Aid personnel at each of the seven permanent big-game check stations were instructed, including demonstration, in the technique employed in obtaining measurements in an effort to insure consistency in the data obtained. These check stations, situated so as to sample large percentages of the non-local hunter traffic, are located at Rifle, Idaho Springs, Monarch Pass, Del Norte, Animas, Ted's Place, and Twenty-five Mile Mesa. The last named station received no elk, while elk checked at Ted's Place are included with the data for Idaho Springs. This was done because there were so few elk checked through there, and it checks some of the same general elk area served by Idaho Springs.

Number and Source of Animals.—Figure 1 shows the location of the seven stations, five of which are listed in Table 1, and the herd areas from which the 1,176 elk measurements were obtained. In the total were 747 usable bull-elk measurements and 429 cow-elk measurements, all obtained from carcasses as hunters brought them through the check stations named. These measurements are almost wholly from the Western Slope, where the largest elk populations and heaviest elk-hunting pressure are found.

Data Obtained.—The information gathered at check stations consisted of the game management unit of kill (there are 93 units in Colorado) ; the number of antler points on bulls; the length of spike or yearling antlers; the circumference of the antlers (six inches above the burr on spikes, and between the second and third tines on older bulls) ; the conjugate diameter (a pelvic measurement defined later) ; the presence of the roots (crura) of the penis; and incidental remarks concerning condition of carcass, manner of splitting, etc.

Anatomy and Terminology.—Although based solely on anatomical characteristics, use of the technique offered here does not require professional training in mammalian anatomy. Only gross anatomy is involved. The one measurement, and the general nature of the observations, involved—all concerned with the pelvic region and therefore the hind-quarters of the animal—are so simple that any technician or conservation officer, capable of following precise instructions, can perform the necessary field work. The measurement and observations required are illustrated in Figures 2 and 3.

The following terms, derived from veterinary, medical and slaughter-house usage, are helpful to personnel responsible for executing

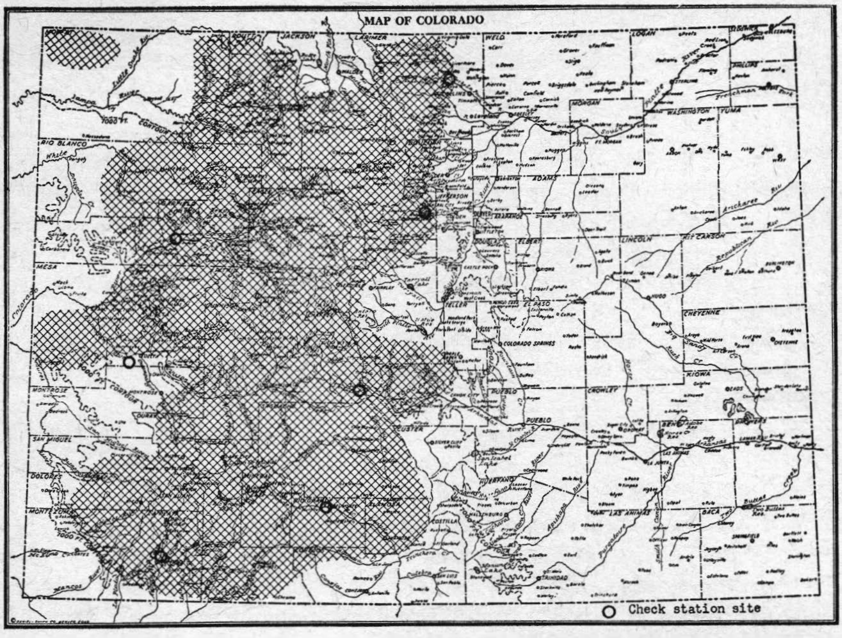

Figure 1. Measurements were obtained from 1,176 elk from herds in the shaded portions of Colorado, 1956-57.

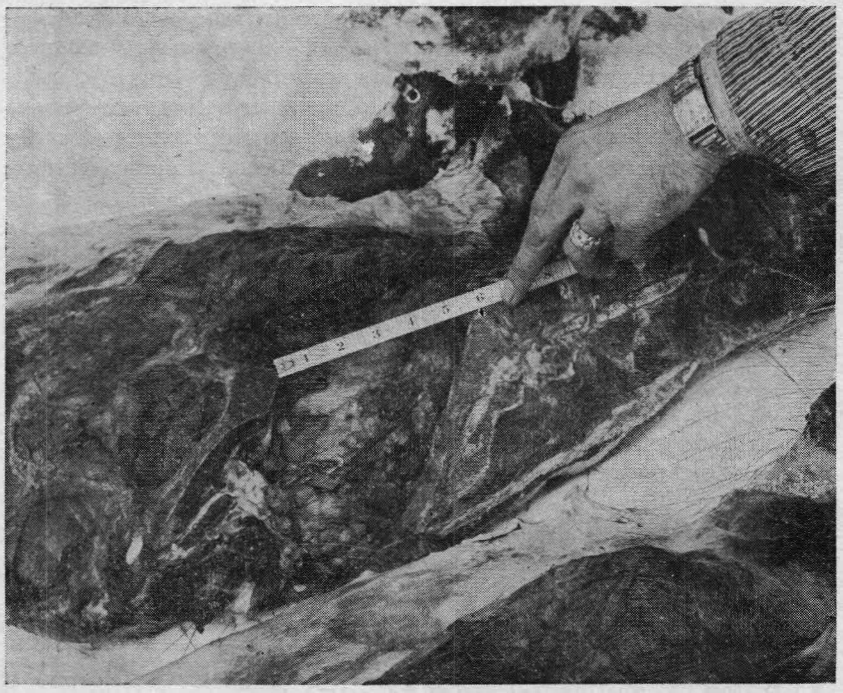

Figure 2. Measurement of the conjugate diameter on a bull elk hindquarter, clearly showing the pizzle-eye at the posterior end of the aitch-bone.

reports and in handling court cases concerned with the identification of sex in elk or other big-game carcasses. These terms are used henceforth in this paper.

Aitch-bone—that portion of the pubic arch exposed as a result of splitting the pelvis through the symphysis pelvis. This structure could be called the split pelvis.

Pubis or *pubic bone*—one of the bones making up the pelvis, located on the front or antero-ventral portion. Plural is pubes.

Symphysis—the line of junction and median fusion between bones originally separated or distinct.

Pizzle-eye—the remains of the crural attachments (roots) of the penis, or the insertion of the penile ligament, located at the posterior end of the aitch-bone on male carcasses.

Cod fat—fat that accumulates in the region of the scrotum or in the scrotal sac of males. Such fat is rough or lobulated in appearance.

Udder fat—fat that accumulates in the region of the udder or mammary glands in females, usually smooth in appearance.

Gracilis muscle—the exposed muscular tissue arising from the ventral or lower side of the pubis or aitch-bone, most apparent on carcasses in which the aitch-bone has been split or separated.

Sacrum—the triangular bone, formed of five fused vertebrae, between the two innominate bones, which in turn are on opposite sides and form the greater part of the pelvis.

Sacral promontory—the anterior ventral point of the sacrum.

Conjugate diameter—the ventro-dorsal diameter of the pelvic inlet or superior aperture, from the pubic symphysis to the sacral promontory.

Rounds—the muscles surrounding the femur or upper leg bone, also referred to as the hams.

Measurement Techniques.—The conjugate diameter was measured with a steel tape to the nearest eighth-inch in animals for which the sex was definitely known, as illustrated in Figures 2 and 3. Quartered and split carcasses were the easiest to measure, although measurements from hog-dressed or halved carcasses, in which the aitch-bone

Figure 3. The conjugate diameter of a cow elk, showing the typical thinner anterior portion of the pubic symphysis and the flatter aspect of the aitch-bone.

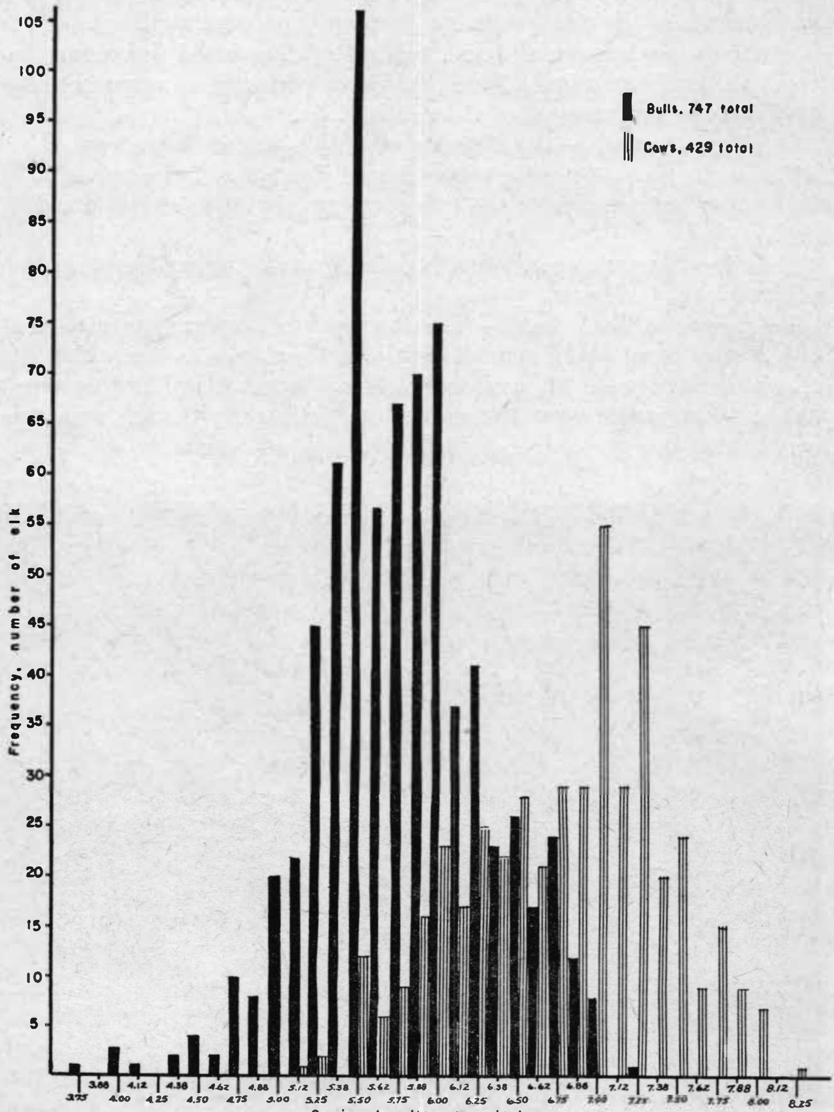

Figure 4. Frequency distribution of the conjugate diameter of Colorado elk, in inches, 1956–57.

was not split, were the most reliable. It was felt that measuring to the nearest eighth-inch was accurate enough, since the manner in which the pelvis is usually split could easily modify the measurement by this amount. One difficulty encountered was the situation where the carcass had not been split exactly down the median line; in such cases, however, the difficulty was alleviated if the same quarter held both the sacral promontory and the pubic symphysis. When they were on opposite quarters, the only way to obtain the measurement was to put the two hindquarters carefully together so as to re-form the true conjugate diameter.

In some cases it was found that when the aitch-bone had been split, the pelvis had been sprung or broken-down, introducing the possibility of spreading the innominate bone away from the sacrum, thus increasing slightly the conjugate diameter.

Ability to distinguish the pizzle-eye depends on how cleanly and nearly-centered the aitch-bone is split. The elapsed time that the meat has hung in camp, or elsewhere short of refrigerated storage, has a distinct bearing on the ease by which the pizzle-eye can be defined, due to shrinking of the gracilis muscle and adductor muscle, and drying of the penile root itself against the posterior aspect of the ischium of the pelvis. In such instances, cutting along the posterior edge of the ischial arch will reveal the ligamentous attachments, or the crural tubercles, of the pizzle-eye in male carcasses.

RESULTS

Statistical Analysis.—A total of 747 bull elk and 429 cow elk conjugate diameters mere measured and analyzed. Figure 4 illustrates the frequency distribution of these measurements. A similar analysis of the original 89 measurements in the preliminary investigation in 1956 (Denney, 1957) did not exhibit the overlap found in this larger sample, the reason for which is not exactly known. The overlap in the present data necessitates dependence on other sex characteristics in classifying questionable carcasses, and by which the necessary accuracy can be attained.

In Table 1 the data from the various check stations do not vary so much as to indicate appreciable differences in the elk herds of the state but, instead (when other circumstances are known), indicate that broken pelvises and inconsistencies in the manner of measuring between stations and individuals are involved.

In Table 2, the mean bull elk conjugate diameter is 5.77 inches, and the average cow elk conjugate diameter is 6.78 inches. The standard deviation for bulls is 0.52 inch; for cows, 0.63 inch.

TABLE 2. ACTUAL AND CALCULATED VALUES FOR COLORADO ELK, AS INDICATED, 1956-57

Subject	Bulls	Cows
Number in sample (N)	747	429
Mean conjugate diameter, inches	5.77	6.78
Standard deviation, inches	0.52	0.63
Standard error of the mean	0.02	0.03

A statistical comparison by the "t" test (Snedecor, 1956) yields $t = 31.49$, with infinity degrees of freedom, while the tabular value of t.01 is 2.57. Significance is indicated if the t-value is greater than the tabular value. Thus, the average cow elk conjugate diameter is significantly greater than the average bull elk conjugate diameter, at the one per cent level, which further substantiates the hypothesis that the average conjugate diameters are significantly different.

When the original study in 1956 was subjected to the following analysis (Grieb, 1957): $N = \frac{(t.01)^2 s^2}{(.05\bar{x})^2}$, where N equals the number of measurements needed, t.01 is the tabular value of t for the number of observations already made, s is the standard deviation of the preliminary data, and $\bar{x}$ is the arithmetic mean, it was found that 425 bull and 564 cow measurements were required in 1957 for results within one per cent of the mean 99 times out of 100. It is evident that these requirements were exceeded in the bull measurements, but were not attained in cows. In analyzing the new data by the same size-of-sample formula, it was found that 565 bulls were needed to be within one per cent of the mean 99 per cent of the time, and 572 cows for the same degree of accuracy. The validity of results from the 429 cows obtained, therefore, lies between the 330 needed for being within five per cent of the mean 99 per cent of the time, and the one per cent level. These data are, therefore, both revealing and satisfying, since it is the 95 per cent confidence level that is most widely used in sampling.

Some interesting facts arise when the obvious characteristics of the spike or yearling bulls are analyzed. For example, 325 spikes showed an average antler length of 16.31 inches; 295 yearlings possessed an average antler circumference of 3.58 inches; and 353 spike bulls indicated an average conjugate diameter of 5.46 inches. The difference in the number of yearlings referred to is because all information sought was not available on every animal checked. A line graph of the frequency distribution of the conjugate diameters (not shown) would indicate an irregular normal curve, the sub-peaks of which might well indicate age classes. This is true of yearling bulls, obvious also in

Figure 4, and may be found to be true of other data when more information is acquired. Yearlings, as determined from antlers, comprised 43.50 per cent of the bulls checked.

Bulls with six or more antler points averaged 6.02 inches in antler circumference, 6.40 inches in conjugate diameter, and represented 8.43 per cent of the total number of bulls measured.

The 1957 study was restricted to mature, or yearling and older, elk, since measurements on calves of both sexes in 1956 failed to divulge any significant differences, although the presence of the pizzle-eye on male carcasses could be verified. The sex of calves, other than from an informational standpoint is not essential, since under most hunting systems the calves are considered as antlerless animals and are taken on antlerless or cow permits, licenses, or validations.

DISCUSSION

Application of Measurement.—The most common violation in "bulls-only" or an "antlered-only" elk area is that of accompanying a quartered, skinned-out cow carcass with a set of antlers as evidence of sex. Due to the relatively large size of the animals and the remote nature of their habitat, most elk kills are in various stages of dismemberment when encountered in the field or at check stations. During the 1956 hunting season in Colorado, approximately 57 cases were made which involved the legality of possession based on the sex or antler aspects of the regulations in force.

As already indicated, the purpose of these measurements was to determine whether differences exist between bull and cow elk carcasses; and if so, whether these measurements could be used in the absence of other sex characteristics or to augment other evidence, in determining the sex of an otherwise doubtful carcass. The conjugate diameter is known anatomically as a good measurement to differentiate the sexes when sufficient data are available on which to base such a determination (Sisson, 1921).

On the basis of results obtained, a field man not intimately familiar with this subject would still be in doubt in the event of questionable carcasses with conjugate diameters of six to seven inches—the general area of overlap revealed in this study. The following discussions will aid in revealing the sex classification when specimens with overlapping conjugate diameter measurements are encountered.

Accessory Sex Characteristics.—In addition to the presence of the pizzle-eye on male carcasses, discussed previously, there are several other aids to indicate the sex of a carcass devoid of the normal sex organs.

1. The pubic-ischial symphysis, or aitch-bone, exposed as a result of splitting the pelvis in dressing an animal, is more S-shaped or curved in bulls due to the more massive structure of the pubes. The flatter surface in cows probably facilitates passage during calving. The thicker anterior section of the pubes in males has been noted also in white-tailed and black-tailed deer (Taber, 1956). The pubic arch is wider and more U-shaped in the female, while it tends to be V-shaped in the males; and the crural tubercles from which the pizzle-eye arises are present on the inside of the V near the junction of the sides. Some measurements have also indicated that the aitch-bone is longer in bulls than in cows.

2. Sometimes difficult to distinguish in game animals because of their sparse covering of fat, but nevertheless quite apparent when present, is the difference in cod and udder fat. Most elk hunting occurs during or just following the rutting season, and fat is noticeably lacking on most bulls at this time. If present, however, it has the characteristic lobulated appearance, while the udder fat of cows is smooth by contrast.

3. The comparative shape of the gracilis muscle helps indicate the sex since it is more fully exposed in depth and extends along more of the aitch-bone in cows than in bulls. It generally appears to be more restricted posteriorly along the aitch-bone in males.

4. The differences in general pelage color and markings of hides (when hides are present) are, of course, familiar to all who work with elk. The bulls range from a generally lighter to creamy body color, with darker mane and legs than normally found on cows.

5. The canine teeth, commonly called buglers or whistlers, are distinctive in the sexes also. Although the writer has done only exploratory measuring in this field, it appears that of length, width, and weight measurements, width criteria seem to be most definitive. Twelve measurements on bull teeth ranged from 17 to 19 millimeters in width, averaging 18. Thirty-one similar measurements on cows ranged from 12 to 16 millimeters, averaging 14.41. Bull canines averaged 2.52 grams, and cow canines averaged 1.79 grams, in weight.

6. The color of the meat is rather relative, but the much darker meat, particularly the flesh of the hindquarters, of bull elk has been observed, and commented upon, by men in the meat-processing business and by Department field men.

7. The general conformation of the sexes in elk is distinctive, the males being generally much larger, coarser, and with more prominent rounds. In other words, it would take a young or small cow elk to

have the same general conjugate diameter measurement that a large bull elk has.

Many oldtimers, both wardens and hunters, claim to be able to distinguish the sex of elk meat without the aid of external indications. Such skill is probably held by some individuals, but when asked as to the criteria used, it usually develops that intangibles or ". . . something I just can't put my finger on . . ." are depended upon. Such ability, if held at all, undoubtedly stems from long observation of some of the characteristics described herein, interpreted through familiarity and experience.

Some of the veteran poachers advise younger violators to chop up the pelvic bones on an illegal cow elk so that no one can prove it wasn't a bull. Evidence of unnecessary removal or mutilation of the pubic bones, thus prohibiting detection of the pizzle-eye or the conjugate diameter measurement, would be grounds for an intensive interrogation and investigation of the hunter concerned. Sometimes, though, the pubic and ischial bones are justifiably cut back closely to the hams when the quarters are packed out in panniers.

NEED FOR FURTHER WORK

The Colorado Department of Game and Fish plans to obtain further data to permit more valid investigation of some of the correlations now indicated. In forthcoming seasons it is hoped that stronger correlations can be made between age and conjugate diameter. Also, efforts will be made to pursue some new measurements which now appear promising as sex indicators.

A ratio or formula may well be devised in future studies that will accumulate and compound the differences in sex-characteristic measurements to the point of excluding the overlap exhibited in the conjugate diameter measurements when used alone.

In time, it seems probable that a set of correlating factors will be established which would reveal that a cow carcass with certain measurements, accompanied by antlers likewise possessing certain measurements, would present an utterly impossible combination of factors, or indices, thus indicating that the possessor was violating specific big-game regulations.

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Lastly, my sincerest thanks are due the hundreds of hunters who possessed the patience and cooperative spirit to wait at check stations while needed measurements were obtained.

SUMMARY

1. A total of 1,176 usable elk measurements were obtained from six permanent big-game check stations in 1957.

2. A total of 747 bull elk conjugate diameters averaged 5.77 inches, with a standard deviation of 0.52 inches; and 429 cow elk conjugate diameters averaged 6.78 inches, with 0.63 inches of standard deviation.

3. The statistical reliability of this measurement is from within three to one per cent of the mean 99 times out of a hundred.

4. Spike or yearling bulls showed an average antler length of 16.31 inches, an average antler circumference of 3.58 inches, and an average conjugate diameter of 5.46 inches.

5. Six-point or better bulls had an average antler circumference of 6.01 inches, a conjugate diameter of 6.40 inches, and comprised 8.43 per cent of the total bulls measured.

6. Some overlap in conjugate diameter measurements necessitates relying on certain other sex determinants to substantiate the sex:

a. The pizzle-eye is the ligamentous root of the penis, found at the posterior end of the aitch-bone in males.

b. The pubic symphysis is deeper in cross-section, the aitch-bone is longer, and the ischial arch is narrower or more V-shaped in bulls than in cows.

c. Cod fat is lobulated and the udder fat is smooth in appearance.

d. The gracilis muscle is more fully exposed against the aitch-bone in cows than in bulls.

e. Hides are generally lighter in color with darker mane and legs on bulls than in cows.
f. Canine teeth are wider and heavier in bulls than in cows.
g. The flesh is usually darker, comparatively, in large bulls than in cows.
h. Bulls are by general conformation larger, coarser, and with more prominent rounds than cows.

7. Further work in obtaining measurements and correlative factors is indicated and briefly commented upon.

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DISCUSSION

DISCUSSION LEADER SEVERINGHAUS: I would like to know whether or not those measurements and other characteristics have held up in court.

MR. DENNEY: The accumulation of data, each supporting the other, has stood up a number of times in court. In 1956 we prosecuted and won a total of 37 cases which involved a question of legality in connection with elk possession. In the last year we have found that the criteria presented have stood up very well in court and, to my knowledge in a case I have been involved in, have won that case.

I have tried to point out to you, in connection with the use of some of this material here, that you should not rely on any single piece of criteria, but to use a combination of techniques. We have had success in that manner.

DISCUSSION LEADER SEVERINGHAUS: With regard to the big difference in age that you can have, have you entered age criteria in determining or settling your court cases?

MR. DENNEY: That is something that we intend to go into deeper during the coming year. So far we have not used this to any large extent to make any determinations.

TECHNICAL SESSIONS

Wednesday Morning—March 5

Chairman: DOUGLAS E. WADE
Editor, *Journal of Soil and Water Conservation,* Des Moines, Iowa

Discussion Leader: F. O. CAPPS
Chief, Education-Information Division, Missouri Conservation Department, Jefferson City, Missouri

CONSERVATION EDUCATION

RESOURCE MANAGEMENT AND HUMAN ECOLOGY

GEORGE B. HAPP
The Principia College, Elsah, Illinois

Ecology is the science of living entities in relation to their environment. In human ecology, man is the main living factor concerned. In resource management, the emphasis is on resources, and man is often one of the major environmental influents. Man's outstanding capacities for making choices, experiencing changes and rearranging effectively the capacities of his environment frequently place him in a determinant position in the development and practice of resource management—and it is man's position in a broad ecological aspect, that human ecology is contributing to the management of our natural resources.

RESOURCE ECOLOGY

Some of the ecology of the animate and inanimate resources of the world have undoubtedly been apparent in various ways to man since his advent on this globe. The observations of these resources in their contacts with their environment under the term ecology introduced by Haeckel in 1869 (Woodbury, 1954) have become increasing perceptible in an objective logical frame of reference. Ecology is gradually emerging both as an art in its attractive aspects, and a science of logical arrangement and analysis in its own right. Man's acquaintance with his natural resources often proceeds first along the lines of his unfolding awareness of the living world around him. This awareness is often followed by a logical analyzation of the organization and function of these organisms. The advances in the art of understanding these natural resources have been numerous over the years — corresponding advances in a scientific approach to them and their relative functions is now timely. Today, the ecology of natural resources is becoming apparent in a cause-to-effect sequence in the customary ana-

TABLE 1. AN ANIMAL OR A PLANT IN RELATION WITH ITS ENVIRONMENT

An Animal or A Plant	*Environmental Conditions*	*Relations*	*Resulting Conditions*
An Animal *Physical Structure* Form Size Color Protoplasm *Psychical State* Intelligence Instinct Reaction Ignorance *A Plant* *Physical Structure* Form Size Color Protoplasm *Patterned State* Tropism Habit Reaction	*Animate Environments* *Human Conditions* *Physical Structure*: Form, Size, Color, Protoplasm *Psychical State*: Intelligence, Intuition, Reaction, Ignorance *Animal Conditions* *Physical Structure*: Form, Size, Color, Protoplasm *Psychical State*: Intelligence, Instinct, Reaction, Ignorance *Plant Conditions* *Physical Structure*: Form, Size, Color, Protoplasm *Patterned State*: Tropism, Habit, Reaction *Inanimate Environments* *Edaphic Conditions* Chemical State Physical State Moisture Content Temperature *Aquatic Conditions* Chemical State Physical State Temperature Light *Atmospheric Conditions* Chemical State Physical State Temperature Humidity Light Wind	*Cooperative Relations* Cooperation Coordination Toleration *Disoperative Relations* Even Competition Uneven Competition Dispossession Destruction	Stability Security Survival

(Happ, 1956)

lytical approach to the scientific method applied in the physical sciences. Newton and other initial observers of facts and related values at first experienced an intuitive recognition of these facts. This recognition was followed later by a more exactly discerned awareness related logically in an overall scientific synthesis. This same procedure is now being followed in studies in general ecology and its application to resource management.

An approach to such resource management may be made through a correlation of the ecology of natural resources and humans in a logical arrangement. This is presented in Table 1 in a summarized outline partially common to both areas. The terms used on the chart are in tended only as indicators of the general areas of consideration.

In this chart, the column at the left refers to either an animal or a plant resource. Each resource is considered as a combined whole physical-psychical (Scott, 1957) or physical-patterned entity. The physical-psychical state in an animal is readily evidenced in its physical structure and behavior and similarly the physical-patterned state in the plant is apparent in its physical structure and its habits and tropisms.

The next column to the right refers to the environment of a resource in token terms of humans, other animals, plants, soil, water and air.

The third column to the right refers to the relations between a resource and its environment. These relations are indicated in two groups, cooperative ones such as cooperation, coordination and toleration, and disoperative or opposing ones, even-competition, uneven competition, dispossession and destruction. For instance, where the resource and the environment are found to have common values and conditions in which they mutually support each other, the relation may be cooperative. When the conditions and values are dissimilar and oppose each other, their relations may be competitive or even destructive (Allee, 1949; Ford, 1955).

The last column at the right indicates briefly the resulting conditions of the resource and the environment respectively in stability, security and survival.

Each individual factor of a resource and its environment at one point of contact form a pair event (Chapple and Coon, 1942). There are, of course, many different points of contact between each resource and its environment. The ecological pattern initiated by the resource and the environment in contact develops into a resource-environment-relation-result sequence. The resource and the environment in a pair event in ecology are similar in logical sequence to a pair event in chemistry when one element such as oxygen and another element, hydrogen, in contact, experience cooperative group relations and resultant stability in their combination as water.

It is recognized basically that all biological resources exist with choices and changes initiating conditions which recur repetitively until other choices or changes occur with similar consequent repetitions. Through these choices and changes the expressed conditions of the resource and of its environment may vary causing changes in relations and in resulting conditions.

This resource, its environment, the point of contact, their relations, and results, occur as follows. A Douglas-fir growing in an elevated mesophytic environment in the West may be in coordinate relations with its climatic environment and experience considerable stability, growing large and sturdy. Another Douglas-fir, located at a lower elevation in a more xerophytic environment may be in opposing relations with its less favorable climatic environment and experience considerable instability, being smaller and less sturdy. A third Douglas-fir, a seedling, growing farther out in the desert in contact with a very xerophytic surrounding and experiencing opposed destructive relations with its climatic environment, does not survive.

Similarly, red-shafted flickers living in a mesophytic valley in the Middle West may establish cooperative relations with nesting sites in trees with considerable stability satisfactory for the raising of their young. Farther west, where trees are very scarce, some flickers with opposing competitive relations may establish nests in occasional telephone poles in more scattered nesting territories. Still farther west in the flat, open plains, other flickers may find no suitable nesting sites and as a result their nesting territories are non-existent. The different conditions in the causative environments of the resources, Douglas-firs and flickers, initiate their different relations and the resulting gradations of success or failure.

The different conditions of the resource and its environment in contact at one point may initiate the different types of relations and resulting conditions which may be expressed more precisely in hyphenated form. For instance, a coyote in a well-watered mountain valley with abundant rodents, may frequently catch and consume the rodents with cooperative relations and excellent subsistence stability for the coyote but destructive relations and non-survival for the rodents. These different relations and results for the resource and the environment in contact are expressed in a hyphenated form as cooperative-destructive relations and stable-non-survival results.

The conditions of a resource and its environment in contact in a pair event are apparent more precisely when it is recognized that they occur at a particular time. This connection of an occurrence with a particular time is commonly used in the observations in the physical sciences.

While changes in structure and behavior or habit in some wild animal and plant resources may have occurred to some extent over many years, as in the digger wasp, *Bembix* sp. (Evans, 1957), the changes in environments have occurred sometimes extensively over much shorter periods due to man's dynamic direct or indirect influence on this environment. These environmental changes have in turn often caused changes in the inter-relations and in the resulting conditions. For example, the changes in values in the different forest environments in contact with the ivory-billed woodpecker undoubtedly have contributed to the woodpecker's disoperative relations with this environment resulting in the bird's extinction.

HUMAN ECOLOGY

The changes in structure and behaviors or habits, of domesticated animals and plants, have been often largely initiated and influenced by their contacts with man. These contacts between the organism and the environment contribute often to a trend towards their more co operative relations and their resultant increased stability and survival The increase in size, adaptability and other values in horse, cow, sheep, swine, and fowl amply illustrate the determinative influence of man in these contacts. Through his capacities for expressing more intelligent choices and changes, man is a major determinant in these changes in these animal resources.

The changing environments directly due to man's predations have modified man's relations with the passenger pigeon and the American bison toward destruction and resulted in the extinction of the pigeon and in greatly reduced numbers of the bison.

Constructive trends toward an increase in cooperation and resultant stability may be illustrated in the changes initiated by man in his relation to the forest from the time of the early colonial settlements to the present. Man at first used lumber assets of the forest for shelter, cooperatively for himself and his livestock, and for tools, boats, wagons and other similar equipment of his culture in an advantageous arrangement, but neglected through ignorance, indifference and disoperative relations to assist in provisions for their reproduction. Later, a few men, like Theodore Roosevelt and Gifford Pinchot, with more expressed intelligence contributed toward an increase in cooperative relations for both the lumberman and the forests through establishing national forests under government control. Still later, a more intelligent far reaching change in resource management on the part of the industrial lumber operators has contributed to the selective cutting of trees, the reduction of fire damage in reproduction and the development of tree farms—all conducive to greater resource stability.

Similar changes, awakenings to more intelligent thinking, are occurring in man's direct contacts with many other natural resources—waterfowl, fish, water, soil, minerals and so forth. It is apparent that these choices and changes are also affected and influenced indirectly by many other changes and choices in man's whole culture and civilization. A brief survey of human ecology on Table 2 similar to that previously used to explain resource ecology may aid in recognizing and understanding better man's contacts with his natural resources.

TABLE 2. MAN IN RELATION WITH HIS ENVIRONMENT

A Human	*Environmental Conditions*	*Relations*	*Resulting Conditions*
Physical Structure Form Size Color Protoplasm *Psychical State* Intelligence Intuition Reaction Ignorance	*Animate Environments* *Human Conditions* *Physical Structure*: Form, Size, Color, Protoplasm *Psychical State*: Intelligence, Intuition, Reaction, Ignorance *Animal Conditions* *Physical Structure*: Form, Size, Color, Protoplasm *Psychical State*: Intelligence, Instinct, Reaction, Ignorance *Plant Conditions* *Physical Structure*: Form, Size, Color, Protoplasm *Patterned State*: Tropism, Habit, Reaction *Inanimate Environments* *Edaphic Conditions* Chemical State Physical State Moisture Content Temperature *Aquatic Conditions* Chemical State Physical State Temperature Light *Atmospheric Conditions* Chemical State Physical State Temperature Humidity Light Wind	*Cooperative Relations* Cooperation Coordination Toleration *Disoperative Relations* Even Competition Uneven Competition Dispossession Destruction	Satisfaction Stability Security Survival

Similar to Table 1, the column on the left refers to man, the whole psychophysical man. It is recognizable here that his expressions of intelligence apparent in his behaviors are one of his most powerful forces in making choices and experiencing changes and initiating relations and ensuing resulting conditions. In this arrangement, intuition replaces instinct, which is perhaps more prevalent in lower animals.

The second column again contains the token terms of the environments of man—other men, animals, plants, soil, water and air.

The third column includes the ecological relations as previously in Table 1—cooperative and disoperative relations expressed in token terms of cooperation, coordination and toleration and even-competition, uneven competition, dispossession and destruction respectively.

The fourth column has the resulting conditions in degrees of satisfaction, stability, security, and survival.

From an ecological and behavioristic viewpoint, human intelligence may be recognized as the ability of man to make choices and experience changes in his contacts with his environment, which maintain or increase his degrees of stability, security and survival. This trend of expressed intelligence toward security for man is also accompanied by the maintenance or increase in the trend toward cooperative relations and away from destructive ones. Also, eventually as degrees of man's individual stability increase, the trend toward mutual stability for both him and his environment increases also.

This chart arrangement may bring into clearer view many of the factors in human ecology which affect directly and indirectly the procedures and practices in resource management.

MAN'S MORE DIRECT CONTACT WITH NATURAL RESOURCES

Man's more direct contacts with the natural resources of his environment are influential and determinative in the management of these resources. The intelligent application of sound management policies between man and the resource occur in the establishment and enforcement of laws to protect migratory birds and in other regulations for the balanced maintenance of wildlife. Such policies help to guard against over depletion on the one hand, such as has occurred with the passenger pigeon and other now extinct species, and against over-populations on the other, as occurs sometimes in the case of the Virginia deer, where the deer has often either become a nuisance or has starved for lack of food. Another phase of the program includes the maintenance, as far as possible, of the status quo of desirable biological and geological features in our national parks and monuments. Advancements in the education of our professional conservationists and wildlife managers illustrate further cooperative efforts toward sound resource management.

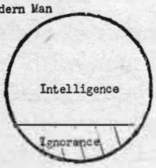
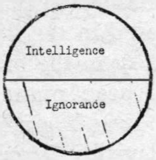
In the Mississippi valley, the well placed and ably managed waterfowl refuges illustrate further these direct contacts of man with his natural resources. In the Mississippi River and some of its tributaries, man has installed dams insuring more constant channels for navigation. He has quarried the limestone bluffs for building stone and developed the use of this resource for road material and for field limestone in soil enrichment programs. The soil has been retained in place through his contour ploughing and stripping and increased in fertility through crop rotation. Scenic parkways of natural beauty in the bluff and island areas of the Mississippi River valley have been planned and made available. The water areas stabilized by the dams for navigation purposes are contributing also to recreational activities through suitable harbor accommodations. Intelligent procedures are replacing indifference and careless considerations.

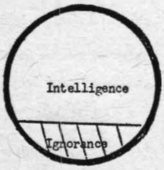
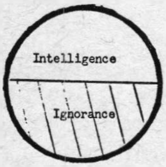
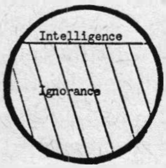
MAN'S INDIRECT CONTACT WITH NATURAL RESOURCES

In the broad human ecological analysis and sequence, as indicated in Table 2, there are also many indirect contacts with his environment in man's experience which contribute to more cooperative relations with and sound maintenance of natural resources.

Some assistance has been gained in understanding better man's resource management policies through endeavoring to analyze from an ecological basis his contacts with his other environments and their indirect integration with his resource management policies. An awakened attitude in long-time planning and foresight in business and industry and in the assumption of more private responsibility has accompanied and influenced the sound policy being developed toward natural forest and tree farm replacement evidenced lately by private individuals and corporations.

Our economic and social advancements in recent years with more opportunity for leisure and recreation have contributed to the increased recreational use of our national parks and other areas. The continuance of amicable social and political relations with the Dominion of Canada have undoubtedly made a contribution to the cooperative establishment of the Migratory Bird Treaty of the two nations. The increase in the number of people equipped with binoculars and interested in our living natural resources is paralleled by the increase in our other special recreational programs. The expanding access to the recreational areas of our natural resources is accompanied

MAN		ENVIRONMENT		RELATIONS (Hyphenated)		RESULTS (Hyphenated)
Modern Man 	+	Managed Wildlife in moderate numbers	=	Much cooperation for many men - some cooperation and some destruction for wildlife	=	More long time stability for man - more long time stability for wildlife
Early Settler 	+	Much Reduced wildlife populations	=	Some cooperation for some men - little cooperation and much destruction for wildlife	=	Short time stability for man - decreasing stability and approaching extinction for wildlife
Early Indian 	+	Early wildlife populations	=	Cooperation for few men - some cooperation and some destruction for wildlife	=	Current stability for small human population current stability for most wildlife

MAN		ENVIRONMENT		RELATIONS (Hyphenated)		RESULTS (Hyphenated)
Modern Lumberman 	+	Modern lumbered and reproductive forests	=	Much cooperation for man - less disoperation for forests	=	More stability for man - increasing stability for forests
Early Lumbermen 	+	Early heavily lumbered and burned forests	=	Cooperation for man - much destruction and reduced reproduction for forests	=	Some stability for man - decreasing stability for forests
Early Indian 	+	Virgin Forests	=	Some cooperation for man - some destruction for forests	=	Little stability for man - much stability for forests

by economic and technological advances in roads and modes of transportation.

Common international economic interests of the Dominion of Canada, Russia, Japan and the United States fostered the establishment and maintenance of the managed fur seal resources in the Pribilof Islands. The breakdown in satisfactory political relations with Russia and Japan has been responsible for a cessation of both nations' participation in the management of this resource. The regulations of the halibut take off the Pacific coast jointly by the United States and the Dominion of Canada have similarly been coordinated with the governmental amity existing between these two nations.

The steps toward international cooperation fostered by the League of Nations have a definite bearing on the international agreements for the protection of whales and of the regulations of the whaling commission. Again, a breakdown of such international agreements during World War II contributed later to a lessening of the effectiveness of the enforcement of these regulations.

Similarly the extent of intelligent leadership of farmer operators with some degree of cooperative relations and social, economic and political stability in a soil conservation district has a direct bearing on the stage of success of their soil conservation programs and practices. The intelligent participation of the individual personnel of a resource management agency contributes markedly to the success and stability of the program.

Most of the situations mentioned are well known examples of resource and human ecology. In these and many other instances, the many intelligent advancements of peoples in their conditions, relations and general success and stability often parallel and are associated with their advancements in their intelligent and sound procedures in resource management.

CONCLUSION

Both man and his natural resources are in transient conditions in the development of capacities and in various stages from cooperation to destruction in the scale of ecological relations. Man's intelligence is defined and apparent in ecological terms and settings as the ability to make choices and experience changes in contact with his environment which results in maintaining and increasing his and its stability, security and survival. Man's expression of intelligence so defined contributes to maintain or increase the stability and security of his natural resources. The relations between man and the resource under these conditions tend toward maintaining or increasing cooperation rather than destruction. Man's intelligent participation in the wise management of the values of his natural resources continues to be urgent and essential. In practical ways everyone participates to some degree directly or indirectly in an intelligent balanced management of these natural resources. Man should be convinced of these ways. Man is responsible for participating actively in the wisely developed and scientifically balanced ecological procedures in the management of our natural resources for the mutual stability and security of man and the resources.

SUMMARY

Both man and natural resources have much in common in their ecological frame of references. The ecological approach in resource management occurs in a resource-environment-relation-result sequence. A comparable ecological approach is applicable in human affairs in a man-environment-relations-results sequence. Increasing objectivity, added precision and a similar technique in the logical analysis of the condition and function of a resource make the values of human ecology and general ecology particularly useful and understandable in resource management. Through a logical pair event approach, man practices ecological management with increasing detail and precision.

Man's direct contacts with his natural resources are often a strongly determinative factor in their management. Man's contacts with his other environments often parallel and affect indirectly the degrees of stability that result from his contacts with his natural resources. More intelligently expressed behaviors in man evidenced in choices and changes and repetitive pattern participating more wisely in the ecology of both himself and his natural resources supports the above thesis and gives impetus to the sound management of these resources. Further recorded studies with illustrations will continue to prove or disprove these conclusions.

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DISCUSSION

DISCUSSION LEADER CAPPS: I couldn't help but think of a statement in connection with resource management that I have heard, that our big problem in resource management is management of people. If people didn't interfere, resources would pretty well manage themselves.

DR. WALTER P. TAYLOR [Southern Illinois University, Carbondale]: The theme of this conference is "Conservation in an Expanding Economy." You indicated stabilization as a highly desirable objective of ecological investigation. Would you approve an amendment in the theme to say, "Conservation in an Economy with Stabilization of Human Beings and Resources"?

DR. HAPP: Thank you, Dr. Taylor. I certainly agree to that. It isn't so much a question of whether we are going to consider that civilization is the ultimate, but we have civilization, and it is going to be a matter of our development of the whole thing. What we must bear in mind is that both man and his resources are in transient stages of development and there are many potentials in each one that we need to develop to bring mutual stability for both man and resources.

MR. JOHN L. STEELE, JR. [Oklahoma Department of Wildlife Conservation, Longdale, Okla.]: I was interested in your paired events in the analysis. Is that a one-at-a-time proposition or an over-all thing? Do you lose your objective or perspective when you take everything into consideration instead of just two paired items?

DR. HAPP: It can be either a single event or parallel events in which there are a number of contacts similar in nature between the resource and man; then you have a whole series of them. It obviously must start with individuals and must be built up in two separate entities at a particular point of contact. The same entities may have a different point of contact on a different topics. In one case they are cooperative; in another case competitive; and another destructive.

This approach is interesting. This is something the anthropologists use and I found it useful in giving definite and specific applications for human ecology. It can build it up that way, and then get away from the generalizations.

MR. ROBERT CURTIS [Michigan Department of Conservation, Munith, Mich.]: I heard a talk by a psychologist at our training school at Higgins lake, Michigan, and he mentioned the idea of how man accepts an idea in dealing with resources and resource management. Could you give your opinion on how man accepts an idea towards our resources in general?

DR. HAPP: In my observations as we get an objective approach to the analyzation that is comparable in one's own experience, and one will probably respond more definitely to the natural resource itself. I think we can all see these things in our own areas clearly, but as we get more logical, more objective, more analytical, and carry these things through the whole sequence, we will win more converts to our whole theses of conservation.

MR. RAY LANE [Havana, Illinois]: As I understand it, man has had to develop a certain amount of intelligence to adjust to his environmental surroundings. But, have we up to this time, developed enough to survive? How much more development will we have to go through to survive as a human race without destroying ourselves?

DR. HAPP: Thank you. This predictability is difficult. But if you will look back in history, since the Stone Age, we have gained greater economic stability and social stability. If man has been doing that in the past, there is a good possibility he will continue, but I don't think any of us can foresee all his potentialities or would attempt to try. We would merely say the sequence from the Stone Age to the present as over-all, has been an increase in stability. And if he will continue to do what he has done, he will continue to advance.

From the human ecologist's viewpoint, every one of our inventions or discoveries are rearrangements of his known factors. The automobile is the metal that was already there. He injects an explosive gas, a spark, puts it on an axle. We knew that these were here before, but we didn't reassemble it that way. That is the novelty. And out of that, man has gone forward to greater flexibility of movement.

Practically everything is of that nature. It is a matter of the reassembly of ideas tangibly attached to something in our environment. That has made his progress. We see lots of evidence right now of that progress. We may be a little optimistic, but I think he will continue that way.

CAN WEAK-KNEED PUBLIC EDUCATION RETAIN RARE WILDLIFE VALUES?

J. V. K. WAGAR

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Russian Sputniks have created a favorable new climate for all education. With their advent our aging civilization, concerned for its treasure of democracy, perceives we must end complacency. We must make courageous decisions—soon! Life, liberty, the pursuit of happiness, and our sacred honor are worth risking fortunes, ease, and lives for.

We who weigh conservation in a destructively expanding economy, along with our weak-kneed failure to educate the *public* for adequate support of rare wildlife and recreational values, are more grateful for than fearful of man-made spheres orbitting around us.

What is our chief concern as wildlife managers? Is it rare wildlife resources for which we have pledged responsibility, or is it security? We answer with probabilities. People still will hunt though the last game birds surviving amid the world's crowded and artificialized coverts include only China's hardy ring-necked pheasants. Fishermen still will challenge the unknown with bait though Europe's carp may be the last fish to exist in our violated streams. And, of course, carp are much more efficient food producing organisms than cannibalistic bass and trout. Lagomorphs and deer should persist, though bungling human populations and land uses send the chamois, wisent, bison, bighorn, elk, and moose after the dodo.

As wildlife management increasingly resembles animal husbandry—with growing emphasis upon nutrition, genetics, and enrichment of feeds—wildlife managers will gain more praise than they do now, when nature is credited with many of their accomplishments. Wildlife managers probably shall always have jobs, and their work will be enjoyable, though each manager's mastery of his science—be it artificial fertilization of mountain lakes, the introduction of exotics, or the mechanization of habitat—obscures his memory of Leopold's proverb that the enjoyment of wildlife is inverse to its artificiality.

Then why do we worry? We fret because journalists (who educate the public more than we do) write that it is absurd to concern ourselves with the whooping crane, which they remind us is neither pretty nor good to eat! Our vacation advertising agencies boast of unlimited, unspoiled spaciousness—in states and provinces so crowded that wolves and grizzlies are extinct, caribou herds dwindle pitifully, lake trout vanish before engineer-ushered lampreys, and remnant herds of wild horses are killed and canned for dog food.

We hold a West Point Conference on the Fitness of American Youth and recommend more setting-up exercises and supervised play, while terming any valley without a highway "inaccessible," and while making labyrinthic motor boulevards of our national forests and parks instead of great adventure lands for people with more time and money for vigorous wildland living than history has known.

Does no one recognize our predicament? Many do, but few are mature enough to admit it completely—and publicly. One wonderful example is Pittsburgh's Carnegie Museum with its Wildlife Obituary. It lists, as the approximate dates of disappearance in Pennsylvania, the Carolina paroquet, 1800; bison, 1801; wolverine, 1863, mountain lion, 1871; elk, 1875; wolf, 1890; fisher, 1900; passenger pigeon, 1906; chestnut, 1930; ?, 1960. Then it asks, "How did these Pennsylvania natives get crowded off the map by one immigrant species?"

The Moraine Park Museum in Rocky Mountain National Park contains an exhibit with admirably delightful candor. There, beneath a huge trout, one reads:

"Where's the best fishing?"

"Probably in Canada!"

"In the park, due to heavy fishing pressure, nearly all accessible areas are fished out by mid-June. It still is fun to try, though."

Such statements, unfortunately, as reminders or measures of our outdoor status, are rare. More commonly we read the proud statements of metropolitan newspapers, game and fish departments, tourist bureaus, and forest and park supervisors and superintendents, in terms of deer populations, hunter success percentages, total kills, visitor numbers, and dollars spent.

Our measures are faulty. Most outdoorsmen today are city folk, living with other city folk whose standards are low. A hunter departs from main street. A few days later he returns in one of two ways to his neighbors, with or without a deer! How he obtained it is unimportant to most people. What other experiences he could have enjoyed are suspected only by outdoorsmen of great intelligence or experience.

Or consider travel. Today's customary measures are the distances we have travelled, the list of famous places we actually have looked at, and the number of pictures taken.

Obviously our education is elementary, and wildlife experts are not educating the public. We have a new education in firearms safety, outdoor living, station wagon and family camping, and wildlife predation through hunting and fishing arts. New millions learn that outdoor living, travel, and resource harvests can be safe, fun, socially approved, and cheap. The havoc wrought by these new harvesters before they learn to appreciate and conserve, and their usual ignorance of what lies beyond very ordinary experiences, is appalling. Most instructors in this tide of outdoor living schooling are general educators, physical educators, or writers whose knowledge of wildlife and wildlands is markedly limited. Admirable exceptions occur, but they are few.

In eagerness to be hospitable to the recreating public, or to obtain their dollars, we assure modern harvesters that everything is easy or shall be made so. If good roads don't enter magnificent areas, we'll build some. If native species can't supply public demand, we'll introduce exotics—everywhere. Then we wonder why dude ranchers and wilderness outfitters, who base their patronage upon a more demanding experience, lose business, why wilderness areas and wildlife vanish with little protest, and why the remarkable skill of advanced outdoorsmen seldom is seen. What else can we expect when the one-eyed teach the blind?

Park superintendents say "You can't keep the people from seeing their parks." Forest supervisors say "You must treat all people alike. You can't let some people build fires outside regular campground stoves and not others!" Game and Fish Department directors say, "We must give every person the same privileges!"

The old apprenticeship of the tenderfoot has been banished by commercialized tourism and a new mythical western hospitality with eagerly outstretched palm. The old disciplines imposed by nature upon the foolhardy, selfish, and ignorant have been removed by modern transportation, communication, gadgets, and helpful rangers and conservation officers. No adequate replacement for such ancient disciplines is imposed, though we scourge ourselves with complaints about our national lack of discipline. A firm, melioristic education is needed.

Time-tested, well-known solutions are evident in our best educational institutions. We reward the thoughtful, the disciplined, the apprenticed. We withhold privileges from the incompetent, greedy, and those unwilling to develop skill and understanding.

If, no matter how much we learn, we are treated as beginners, why learn? If we are never told of rare experiences available to us, once we have served our apprenticeship, why be more than a road hunter or a duffer? And how can we obtain more wilderness areas, parks, or public shooting grounds when we pretend that those which now exist have an unlimited carrying capacity? Education which amuses and interests without demanding harvester conformance with known facts scarcely deserves the name "education." And it cannot assuredly give us the conservation we desire.

Many of us serve the people in state-supported universities. These belong to the people. We deny admission to their sons and daughters until they meet entrance requirements. We dismiss them if they fail to maintain reasonable academic standards. For advanced courses we require definite prerequisites. We permit graduate students to browse through library stacks. We deny this privilege to undergraduates. We do make differences between people, and they pay the necessary cost. We insist that we know good educational standards, and we explain these to them. We accept complete responsibility for the resource entrusted to us. We reward those who meet our standards with a certificate. We are demanding, and our business was never better.

Some state park systems turn away campers when all legitimate camp sites are occupied, just as hotels turn away guests without reservations unless vacancies exist. Grand Teton National Park operates campgrounds for large groups upon a reservation basis. Grand Teton and Mount Rainier National Parks permit climbers to scale their major pinnacles only after registration granted to those whose experience, equipment, and plans are approved. National parks issue campfire permits to experienced outdoorsmen who traverse their wilderness areas.

A few progressive game and fish departments blacklist habitual law violators. Some demand that youngsters buying big game licenses must certify their ability by presenting a previously held license or a firearm handling course certificate. Why should we not certify all big game hunters, demanding that they be able to hit an eight-inch bullseye three out of five shots at 100 yards, from any position? Why shouldn't we examine duck hunters for their ability to distinguish legal waterfowl from rare, protected swans and cranes? Why shouldn't we grant licenses for game managed upon a limited permit basis first of all to those who have demonstrated predictable deportment and steadying experience? Why shouldn't those of us who are told to take special privileges because of past experience as forest rangers, game wardens, and wilderness travellers be certified? Why shouldn't game departments provide special permits (paid for by the permitees) for experienced hunters who wish to use ancestral weapons of proved potency, but which do not precisely meet arbitrary standards? We conclude that weak-kneed education cannot save rare wildlife values.

We who are wildlife and wildland resource managers need to describe the recreational enjoyment inherent in our responsibilities in terms transcending hunter success, scenery viewed chiefly through windshields, and proof of travel bought in curio shops. Then by rigorous delineation and restrictive certification, we may grant greater freedoms to those who merit them.

We need to instill in the harvesters of our resources the admirable purposefulness of the plump lady whom the golf professional was coaching to employ "a smooth, effortless swing."

Said she: "Young man, I don't want 'a smooth, effortless swing.' I'm trying to lose 20 pounds!"

We have in 1958 more than Sputnik to jolt us from the rut of easy outdoor living habits and an unquestioning acceptance of incomplete wildlife populations and habitats. In this 100th anniversary of Theodore Roosevelt's birth and the 50th anniversary of nationally recognized conservation, we need to follow his advice to live the vigorous life, to gain in some measure his great understanding of wildlife and wild scenes, and like him, to contribute to wildlife conservation more than we harvest from it.

DISCUSSION

MR. E. KLIESS BROWN [Idaho Fish and Game Department, Boise]: Dr. Wagar was my professor when I was in college, and I enjoy his papers every time he gives one, but Jack, one of the difficulties we still have today, even though practically all conservation agencies now concentrate to some degree on conservation education, is that we are still confronted with the practical problem of having to remove stumbling blocks that people put in our way which keep us from doing a thorough conservation job. Do you have any thoughts along this line?

DR. WAGAR: You do face tremendous problems. Politics is one. If game and fish managers don't do a perfect job, somebody says, "Off with their heads." But, there are certain clues there that we see. In Colorado, this year, we inadvertently pulled a boner. We had a statewide hunting season, practically hunter's choice. And we didn't inform the hunters too well. If we notify them of things that are coming months and years ahead, they get used to the idea. We are setting up all the time, greater requirements, not for the purpose of being mean, but to permit these people who meet our standards, to have greater freedom, and by starting in gradually and keeping the public well informed, we have had very good success in imposing this type of public education through regulation.

MR. J. J. SHOMON [Virginia Game Commission, Richmond]: Dr. Wagar, would you give any thought to a broader program of natural resources education at the college level? Those of us who are in this work are constantly faced with the problem of getting people in our employ who have the right kind of conservation communications training, the right type of sensitivity to all natural resources, so that they can dispense some of that feeling to our people. Around the country, I see few colleges and universities that are training conservation communicators to help people like myself and other state and federal people to close this gap between what we know in the sciences and what the general public knows. Have you any thoughts on that?

DR. WAGAR: Yes, a few. It is my privilege to teach as a required subject to all of our students in the College of Forestry and Range Management, at Colorado State University, a general course in the principles of conservation. That gives them some of the thinking which they need.

I am glad you brought this up because what I propose in the way of regulation and restriction is only an approach to conservation education. It is only one; you need many other approaches. And I think this excellent panel, with myself excluded, is going to cover many of those fields.

You know, you can judge a professional man by his abiilty to say no. An MD will tell you, "You like this food, but you can't have it. I said no." A forest ranger says, "I know you want that tree, but we need it for a future stand." A range manager tells a grazer, "I know you want more stock, but the range won't stand it." And we who handle wildlife resources need to tell the public, "We know you want these things, but you can't have them. There is a limited carrying capacity." And we are going to have to work on it that way.

MR. FRANK GREGG [Izaak Walton League, Chicago, Illinois]: I don't know what the accumulative budgets might be that are available to public and private conservation agencies, but it can't be more than a tiny fraction of the talent that is being spent teaching a concept of the outdoor recreation values which is directly contrary to those we cherish. There is more money spent on teaching people that the shooting preserve is the key or that a new spinning reel is the key or a new camp stove. There is probably more money spent just in advertising those products and those attitudes than is actually spent on managing the resources in all the states.

I wonder if you would guess as to whether or not the outdoor education efforts that we all wish to see could ever possibly compete with that kind of a selfish interest program?

DR. WAGAR: Frank, I have got a great deal of faith in human intelligence and I think we can do it. Some of these things can be unwritten rules. As you know, the average hunter does much for his own satisfaction as he parades before his audience. If he comes to us and tells us, "Well, I got a deer and got back before breakfast," we ask him, "Good Lord, couldn't you stand to stay out there longer? Wasn't there anything else to see or hear? Why did you hurry back?" There is no law against a man wearing his hair down to his waist, but we have a lot of social pressure against that. We have a general standard of what a haircut should look like.

A lot of wildlife managers have just been saying, "We are going to produce game, you harvest it." Instead of that, we will have to tell them how to harvest and get the most enjoyment; a lot of people in this audience are doing it. Some of them are wonderful hunters. They force themselves to a greater expenditure of time and effort and come back with a bang-up experience instead of just one dead deer or elk.

DISCUSSION LEADER CAPPS: Dr. Wagar, would you apply your statement on weak-kneed failure to educate the public in a broad sense, rather than limiting it to wildlife or rare species?

DR. WAGAR: I am not sure I quite grasp your question. You mean then, we should expand the fact that our conservation education is weak-kneed to many aspects? Well, I think so. We might pass laws that no car which carries fewer than three people should go over 150 horse power. Gasoline, you know is burned for status today. We drive bigger cars and are encouraged to drive bigger cars than we can afford. One company even asks, "How would you like to have one of these brawny beauties in your drive?" Now, a car doesn't do any good in your drive except for your status. So, we can promote people to think more provocatively.

Getting back to gasoline, that is one natural resource we are running out of. Eighty per cent of the world's petroleum supplies are stacked up against us in Arabia. We have about 17 per cent.

In our town, if you are in junior high school and don't have a bike, you are nobody. If you are in senior high school and do have one, you are nobody.

MR. DON BRADSHAW [Duck and Hunters Association, Alton, Illinois]: I notice in the program, we are discussing education in the junior colleges and in college. I wonder about elementary school and even pre-school children, what you would think of a program to get these younger children outdoors, seeing animals and trying to instill in them some of the esthetics of the out-of-doors. Then when they get to high school and college, you might have a little easier time. Do you think this program is worth consideration by sportsmen's clubs?

DR. WAGAR: I think it is, because it teaches the outward thinking. When we are out of doors, we have to forget ourselves and think of other things. The Chicago schools took youngsters not in biological subjects to the Cook County Forest Preserves and let them observe growing things. All of their grades increased. In other words, they were stimulated to think more deeply, more objectively. There are undoubtedly fundamentals that we have not explored.

Thomas Jefferson wrote back from Europe 160 years ago, "When we become as crowded as Europe, we will become as corrupt as Europe." Democracy takes a lot of thinking, you know, to be fair, Dr. Webb of the Texas Higher Educational Institution says, "Democracy is a frontier phenomenon." Maybe we have space limitation. Maybe when we get back to fundamentals, we forget all the superficiality of position and accent more the fundamentals.

The only trouble is the poor professor. In the classroom, there is no word he doesn't know. He is the expert. You take him out of doors, and he uses three little words very often—"I don't know." He is humble, too.

MR. CARL BUCHHEISTER [Audubon Society, New York City]: I would like to tell Dr. Wagar that I very much appreciated hearing his paper and very much agree with all he had to say. And I wonder if we do not sometimes put the cart before the horses in conservation education. Particularly in teaching children in the elementary schools. It seems to me that the most important thing in the world is to teach children about nature very early in life. Just about nature. So that they begin to understand a little about animals, plants, soil, and water. And when they begin to understand a little the world in which they live, it is very possible, knowing human beings from my experience as a teacher, that if they have built up some understanding. If it can be done first through the head, there is a good possibility it will reach the heart.

And I don't think you can teach conservation in the sense that people should have ethics with regard to the outdoors unless they first feel for the outdoors. It may be axiomatic, but sometimes the old truths are so dulled by repetition, we don't pay attention to them any more.

But I do think that is the most important thing of all.

Now, I don't want to advertise, but for 21 years, I have directed one of the camps run by the National Audubon Society, and we have dealt with raw material, teachers from all over the United States, who admit to us that they have never had any course in a teachers' college about nature. They have never had such a thing and they freely admit that they simply do not know anything about it. But, they would like to know so they can teach their children. I feel that the greatest emphasis should be in teaching children about nature itself and then later teaching them about conservation.

DR. WAGAR: I don't think your words need comment. We agree with them a thousand per cent.

CONSERVATION EDUCATION IN AUSTRALIA AND NEW ZEALAND

Walter P. Taylor
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A personal trip around the Pacific in 1957 made possible the observation and appraisal of some of the problems in conservation being tackled and worked upon in Australia and New Zealand.

All the basic problems are obvious. These include soil and water conservation, development of arid lands for grazing and for agriculture, reclamation and irrigation, provision of recreation for a growing population, adoption and application of national policies regarding division of lands between pasture, forest, and farming, preservation of scenic and natural areas, protection of grasslands, native bush, and forests from damage by fire and overgrazing, control of pests, and policy regarding exotics.

Furthermore, wildlife administration, especially in Australia, having to do with the management and preservation of the species and stocks remaining of the gentlest, most inoffensive, least competitive fauna on earth, is faced with a number of obstacles more difficult than those encountered in wildlife protection anywhere else in the world. Before getting into the details of some of these special problems, let's take a look at the setting for the picture to be painted.

Australia as a Home for Wildlife and Plants

Australia—a great land area strategically located in the far south, last continent to be discovered, is unique among them all. In area, some 2,974,581 square miles, or nearly 2,000 million acres, Australia is about the same size as the United States. Like Texas, Australia is another country of magnificent distances. Its coast line is 12,210 miles long. A single ranch in the interior of the continent is larger than Belgium.

The largest land mass and technically the most advanced in the South Pacific, Australia is a solid bastion of democracy in a vast area where democracy has not always been popular. It is also one of the most interesting, biologically, of all the land areas on earth. It is the most arid continent, 87 per cent of its territory being designated "warm and dry." (Griffith Taylor, 1951, p. 3)

Australia's human population is concentrated in a fertile crescent mainly occupying its east and southeast coastal portions, with its wings reaching northerly to Cairns and westerly to Perth. (Griffith Taylor, 1951, p. 4) It is true that, as Taylor points out (1951, p. 47), Australia as a whole, does not offer much variety in scenery. In the western half an arid peneplain has been raised to a height of 1,200 feet; "while in the eastern third a peneplain has been differentially elevated . . . to heights varying from 2,000 to 7,000 feet."

Climatically the continent varies from temperate in the south and east to tropical in the north and northeast. The extremes of precipitation range from a minimum of 6 or less inches per year in the desert interior to over 80 inches in the tropical, Malayan type rain-forest belt of the northeast.

Trees of the genus *Eucalyptus* occupy a tremendous area over a wide belt of country in the northern, eastern and southern part of the continent, (see Griffith Taylor, 1957, Fig. 30, p. 87), while trees of the genus *Acacia* occupy much of the arid interior of the continent, except for the extensive area of "Fixed Dunes," in the center and west center.

"This covering of a continent by such enormous areas of one-genus trees is, I believe, not found in the other great land masses. Of course there are many species both of eucalypts and acacias. Indeed, there are said to be about 365 of the former and even more of the latter, genus." (Griffith Taylor, 1951, p. 87)

Obviously the variation in topography, slope exposure, winds, ocean currents, and especially extent latitudinally north and south, and longitudinally east and west, is sufficient to afford a wide variety of ecologic niches for plants and, of course, for animals, too.

This authority lists the more important vegetational areas of the continent as follows (Griffith Taylor, 1951, p. 91):

1. Temperate Grassland
2. Temperate Forest
3. Mitchell Grass
4. Open Eucalyptus Forest
5. Saltbush
6. Sandy Grassland
7. Rain Forest
8. Mallee
9. Arid Mulga
10. West Sandy Grassland
11. Open Poor Forest
12. Fixed Dunes

THE NEW ZEALAND BACKGROUND

Located 1200 miles southeast of Australia, New Zealand consists of three main islands a little larger than Britain, in fact, about the size of California. The islands are 800 miles long, 375 miles wide. The North American Pacific Coast is 6,500 miles distant, and the monsoon lands of the Asiatic mainland, 5,500 to 7,000 miles away (Cumberland, 1956, p. 5).

"New Zealand is essentially a land of high mountains and deeply dissected hill land. Hundreds of peaks tower above the snowline, especially in the South Island, the western half of which is a lofty mass of alpine high country penetrated only by steeply walled, U-shaped valleys. From the Tasman Valley, still occupied by a glacier, Mount Cook rises abruptly to 12,349 feet. In the North Island the belt of lofty mountains is to the east; it is lower, narrower and less imposing. But much of the rest of the island is occupied by wide expanses of deeply cut hill country or by an elevated, ash-showered plateau. Lowland areas of easy slopes are few and far between. They occur infrequently and irregularly around the coast. Here alone do large numbers of people live.'' (Cumberland, 1956, pp. 5-6.)

There are three principal natural types of vegetation in New Zealand: forest and scrub (subtropical and temperate rain-forest and beech forest); tussock grassland or steppe, and montane and alpine vegetation. Much of the original vegetation has been rather profoundly altered. The forest and scrub and tussock grassland have been greatly restricted, sown grass and crops have been correspondingly expanded, and in the South Island there is even some man-made desert. (Cumberland, 1956, p. 13.) Cumberland suggests: ''. . . the landscape in some regions has been completely transformed, and elsewhere very noticeably modified. Settlement has expanded and population has more than doubled; farm production has expanded ten-fold, countless secondary industries have been created, towns and cities have swollen and new sources of power have been exploited. On the debit side valuable assets and resources have been squandered and destroyed.'' (1956, p. 3).

New Zealand has been isolated from southeastern Asia for a much longer time than Australia, if, indeed, it has ever been connected with the Oriental mainland. This probably is the reason New Zealand failed to receive the primitive mammalian stocks which peopled Australia (see below). New Zealand's only native mammals are a couple of inconspicuous bats! Thus many ecologic niches remained unfilled right up to the time the white man came. Then, too, as in Australia, only in some respects more so, New Zealand's unusually varied terrain encouraged the importation of many exotic mammals of different habitats and habits.

How Australia Got Its Mammals

According to evidence gathered by the geologists, paleontologists, and biologists, a large proportion of the world's mammals originated in the Northern Hemisphere, including Eurasia and North America. From a primary evolutionary center in these northern lands the early mammals spread south in a succession of waves. When these reached remote areas in the southern continents and through isolation were freed from competition, they took on a new lease of life, and in a way, began the process of evolution or adaptive radiation all over again.

One series of waves rolled into South America, where a second evolutionary center developed from which are derived the anteaters, sloths, and armadillos, as well as a number of extraordinary groups of bizarre hoofed animals, nearly all now extinct.

A similar series of waves developed in Asia and rolled south to southeastern Asia, the Malay Peninsula, and the East Indian region. From these by way of former land bridges these ultimately penetrated to Australia and Tasmania. In this way the island continent was stocked with primitive mammals, the forerunners of the present monotremes and marsupials. Then at some time, 70 million more or less years ago, the land connections between the Malayan region of southeastern Asia and Australia were interrupted. This meant isolation of the mammalian primitives which had already reached Australia. It meant more than that, it meant their protection from competition with the dominant evolving mammals of the Northern Hemisphere. So it came to be that the "Australian marsupials are the best existing example of evolutionary or adaptive radiation in an isolated place" in the whole earth (Darlington, 1957, p. 335).

Along with the invading primitive marsupials and monotremes there were some 50 rats and mice, and 55 bats, all derived from the dominant eutherian mammalian stocks of the North. It is, however, with the handful of native monotremes and the 150 (more or less) marsupials that this paper principally deals.

Well, first, what are the monotremes, and what is their present status? There are two genera of these egg-laying mammals, the duck-billed platypus and the spiny anteater. These are veritable missing links, seemingly indicating the derivation of the mammals from some egg-laying reptile. While they possess hair like all the other mammals, they both lay eggs instead of bearing their young alive. Their mammary glands lack nipples, although they do suckle their young.

Of the marsupials, on the other hand, Troughton (1951) lists no less than 150 species. Like all other mammals, the marsupials are possessed of fur or hair. They do not lay eggs like the duck-bill and the anteater, but bear their young in the usual way. Furthermore, their mammary glands possess nipples. The young are born in a very incomplete state. On emergence from the vagina at birth they crawl over the skin of the mother to the pouch or marsupium, where they remain for the remainder of their developmental period, that is, until they are ready to go out on their own.

Since Australia presented a wide variety of environmental conditions, Old Mother Nature, in the absence of the higher mammals to fill up the gaps in the natural economy, made the marsupials do. So, in place of the moles with which we are acquainted in the northern land mass, there is in Australia, the marsupial mole. Instead of the woodchuck or beaver, the wombat. In place of the squirrels, the phalangers or Australian opossums. The giant gliders (also Phalangeridae) occupy much the same environmental niche as the flying squirrel with us. Our grazing animals correspond, rather imperfectly, to the kangaroos and wallabies. Our predators are represented by the Tasmanian devil (somewhat resembling a wolverine) and the Tasmanian tiger (perhaps corresponding to the coyote). In other words, a whole new set of mammals, found nowhere else on earth, was evolved to fill the available niches in Australia!

WILDLIFE CONSERVATION "DOWN UNDER"

And now what has happened? First, aboriginal man came upon the scene. So far as known, however, in all his "walk-abouts" he did not unduly disturb the native fauna or flora. His principal contribution appears to have been the unfortunate introduction of the native dog, or dingo. A far more significant event was the "discovery" of Australia by the white man in the sixteenth century, and its subsequent occupation.

Says Troughton (1951, p. xix), "The romantic history of the discovery, settlement, and exploration of Australia is associated page by page with discoveries of unique kinds of mammals which were a source of wonderment and controversy to past giants of the scientific world, such as Cuvier, Owen, and Huxley. The basic reason for this absorbing interest is that ancient geological isolation had made Australia both the cradle and preserve of marsupial life, which it becomes a national duty to uphold as far as possible for all time. Unfortunately, the task is as difficult as it is worthy; for, by the irony of natural law, this prehistoric security which aided the slow and varied development of our marsupials has left them unfitted to cope with changed conditions and introduced enemies."

AT THE NATURAL HISTORY MUSEUM, MELBOURNE, VICTORIA

One entire case at this splendid institution (located in the same building with the Art Collection and the Public Library on Swanston Street) is given over to "Rare and Extinct Animals." The specimens, mounted, were collected by William Blandowski, the first Museum Zoologist, 1857. *All have now disappeared from the Victorian countryside.*

Eastern Jerboa Marsupial Mouse	*Antechinomys laniger*
House-building Rat	*Leporillus condita*
Brown Hare Wallaby	*Lagorchestes leproroides*

Pig-footed Bandicoot	*Chaeropus ecaudatus*
Brush-tailed Rat-Kangaroo	*Bettongia penicillata*
Red-tailed Phascogale	*Phascogale calura*
Rufous Rat-Kangaroo	*Aepyrymnus rufescens*
White-tailed Rabbit Rat	*Leporillus apicalis*

Labels inform the visitor that: "In the more settled areas of Australia the unique native furred animals are now reduced in numbers, some to the point of extinction.

"This is due partly to hunting, partly to the introduction of such animals as dog, cat, fox, rabbit, and partly to the clearing of native brush for use as agricultural land.

"These actions have been responsible, in the last 100 years, for causing the extinction of more than 30 per cent of the species native to Victoria, and the destruction of several others to the point of extreme rarity.

"Whilst progress and agriculture are necessary to settlement, even at the expense of native fauna, we can by the maintenance of national parks and the outlay of a little thought and money, preserve at least some survivors of this remarkable fauna."

Some further details of what has been happening will further illuminate the situation. "In the brief State-wide open season of 1931 some 750,000 possums were slaughtered by guns, poison, and snares which usually result in the torture of slow strangulation" (Troughton, 1951, p. xxvi). As far back as 1906, writes Troughton, over 60,000 wallaby skins and 4,000,000 possum skins were marketed in London and New York alone. In 1924, under the misleading trade name of "wombat," over 2,000,000 koala skins were exported. More recently than that, an open season on the koala in 1927 in Queensland, northeasternmost of the Australian states, resulted in the massacre of 600,000 koalas by 10,000 licensed hunters. As indicated by Troughton, this was in spite of the fact that the koala is almost extinct in Victoria, due largely to epidemic disease, and is rapidly disappearing also in New South Wales.

In our experience last year, one simply does not have the privilege of seeing the koala in its natural habitat. Already one must go to some private preserve or zoological garden to see the species at all. The animals are so sluggish, slowmoving and so inoffensive, one could walk right up to them and pick them out of the trees. They do no damage, feeding exclusively on eucalyptus leaves; but they are extremely specialized in their feeding habits—for of the 365 eucalypts in Australia, only about twelve provide the favored diet (Troughton, 1951, p. 137). Even with the approved eucalypts, the koala may evidence a dislike for certain leaves on the basis of age, or possibly of their taste, caused by local soil peculiarities.

"Enslaved to their ever shrinking environment, the slow-breeding creatures are no match for the hazards of settlement, with its clearing, bush-fires, introduced foxes, and disease; not even the platypus is in greater need of that protection and care which public opinion and legislation alone can give." (Troughton, 1951, p. 139). "The fascinating koala is utterly harmless everywhere . . . May their numbers miraculously increase to browse peacefully in sheltered forest reserves, together with many others of our fascinating zoological heritage from the past, under a perpetual protection which Australians owe to them."

In another exhibition case at the Natural History Museum there are a number of mounted birds with a conspicuous label, "New Australians—Attention." With each bird is a card giving its name and some of the main details about it. Each message is in four languages: English, German, Italian and Czech.

The principal label points out that almost all species of Australian birds are protected by law, and gives three reasons:

"Why we Protect our Birds:

"1. Man is capable of exterminating a species and once gone it is gone forever. Our native birds are a part of our national heritage. They belong to this country as you now do. All our children have a right to know and love, for example, the Magpie, Shrike, Thrush and Blue Wren.

"2. Australia possesses a bird life with many species not found anywhere else in the world. For scientific reasons our birds Must Be Preserved.

"3. The birds of a country form part of a complicated balance between animals and plants. To remove some of the birds may bring unforeseen results.

"We regard conservation of our fauna and flora as the responsibility of every Australian. It is now your responsibility too.

"In Victoria the Fisheries and Game Department is responsible for protecting our fauna. The Department will be happy to tell you about its laws."

THE WAIPOUA KAURI FOREST

One of the most interesting experiences enjoyed on our trip to New Zealand was a day in the Waipoua Kauri Forest in the North Island, near Dargaville. This area has been set aside for the "exclusive protection of this most interesting tree," certainly one of the world's outstanding tree species. The forest sanctuary for the protection of the Kauri is some 22,500 acres in extent. Altogether in former times, the Kauri occupied possibly 2,000,000 acres of which not more than 25,000 acres remains. Fortunately, there are many thousands of acres of good regeneration where Kauri forests once existed. Says Entrican of the New Zealand Forest Service (1955, p. 4): "Kauri trees are mostly large in the virgin forest, and their huge crowns rise well above all other trees. The densest area of uniformly good trees, known as Cathedral Grove, lies to the west of the main highway. The two largest remaining kauri trees in New Zealand are also in the sanctuary, and are known as 'Tanemahuta' and 'Te Matua Ngahere.' 'Tanemahuta' is estimated to be 1,200 years old; its height is 170 ft., its girth, 15 ft. 6 in. from the ground is 45 ft. 6 in., the height from the ground level to the first branch is 48 ft., and the area of crown spread is 11,600 square feet. 'Te Matua Ngahere' has a girth at breast height of 53 ft., the girth below its crown bulge is 52 ft. 6 in., and the height from ground level to the first branches is 36 ft."

The announced purposes of the Waipoua State Forest are ". . . the preservation of the indigenous flora and fauna in their natural state, and scientific and like purposes." (Entrican, 1955, p. 11.)

Settlement in New Zealand has meant the removal of much of the original temperate rain forest, so that grass could be grown for sheep. It is a matter of congratulation, however, that steps are now being taken to save the remnant of the kauri.

INTRODUCTION OF FOREIGN SPECIES

The fox, domestic cat, domestic rats and rabbits perhaps are the most significant importations of foreign mammals into Australia. By far the most serious of these, as everybody knows, is the rabbit. According to Troughton (1951, p. 263) Governor Phillip of Australia in 1788 listed three rabbits belonging to the Governor and another two owned by the officers and men. These were carefully *fenced in* and a special game keeper employed to feed and protect them. "Floods swept away the fences, and it is ironical to note that rabbits were reported as 'doing well' in 1825. They have since been doing themselves well in ever increasing hordes at the country's expense, and millions of pounds have been spent for fencing alone to keep them out!"

The rabbits exercised a number of extremely harmful reactions on their environment: (1) By destroying vegetation they reduced large areas to sandy wastes; (2) they upset the faunal balance, as Troughton says, and crowded native animals out from their ancestral haunts, and (3) destroyed the small residue of sustenance ". . . which man might not have grudged the original inhabitants of the land." Another effect of the rabbit's pestiferous status on the native fauna came through "... the tragic trail of the poison cart, with its dreadful mortality of native bird and mammal." One incident of the struggle against the rabbit was the construction, by Western Australia, of "... no fewer than 2,023 miles of fencing...." at a cost of £413,531. (Stead, 1926, pp. 356-357.)

MYXOMATOSIS AND THE RABBIT IN AUSTRALIA

By 1880 the rabbit (European rabbit, *Oryctolagus cuniculus*) had spread so widely that the government of New South Wales offered a reward of £25,000 for any method that would exterminate it. An appeal was made to the famous biologist Louis Pasteur, who suggested the introduction of chicken cholera for the purpose, a suggestion which was very wisely turned down. (Fenner, 1954)

In Uruguay in 1896 there was discovered a new disease, which later came to be known as myxomatosis. In 1918 the Brazilian investigator Aragao suggested that this be tried on the Australian wild rabbit, for in experiments in England only rabbits and developing chicken embryos were found susceptible. Following on Aragao's suggestion, Francis N. Ratcliffe of the Commonwealth Scientific Industrial Research Organization, Canberra, actually made a trial in 1950-51. The experiment seemed a failure. Shortly afterward, however, infected rabbits were found over an area of 500,000 square miles along the waterways of the Murray-Darling system. By the summer of 1952-53 the disease had spread throughout southeastern Australia, and the rabbit population had been reduced to 10 or 20 per cent of its original numbers. While we were in Australia last year, visiting Mr. Ratcliffe and his staff at the Wildlife Survey Section, our host excused himself and said he had to go to court. We learned later that on that exact date he was invested with membership in the Order of the British Empire, in accordance with one of the Queen's New Year honors awards.

Probably no more romantic applications of biological control ever have been made than those which resulted in the abatement of the rabbit pest and, similarly, of the prickly pear nuisance, in Australia. It was unfortunate, however, that the introductions of these invaders could not have been prevented in the first place.

NEW ZEALAND INTRODUCTIONS

New Zealand, with its relatively small number of birds, and its complete lack of mammals (with the exception of the two bats already mentioned) may have suffered more from introductions, if this be possible, than Australia. Since it is impossible for us here to cover all the species, let us give special attention to the mammals, which have been given such meticulous treatment by Dr. Wodzicki (1950) as well as other authors.

The official view of the situation is given by F. R. Callaghan, Secretary, Department of Scientific and Industrial Research, in the Foreword of Dr. Wodzicki's book (1950, p. v.).

"Acclimatization of a wide range of exotic animals in New Zealand has, in the course of a century, caused a series of difficult problems in a land unique in the almost complete absence of native mammals. Many of the species which naturalized themselves readily have become noxious to plant life, the native fauna, soil fertility and to the interests of domestic animals. Their present control involves a large expenditure of time, money and materials. The check they imposed on the best utilization of our land resources can only be guessed."

The Rabbit

The rabbit was not successfully established in New Zealand until about 1864-67. Although the first rabbits were imported from New South Wales before 1838, by 1874 rabbits were present in enormous numbers and in 1882 over 9 million skins were exported from New Zealand (Wodzicki, 1950, pp. 107 and following).

"With few exceptions, rabbits have colonized all areas suitable to them in the Dominion." (Wodzicki, p. 113). "The economic waste," says Thomson (1922), quoted by Wodzicki, "caused by the vast increase of rabbits in New Zealand is incalculable, and certainly represents a loss in stockcarrying capacity of the country which possibly runs every year into millions of pounds. It is not only that they eat up food which would support some millions more sheep than are at present reared, but they destroy large areas of country and yield very little return for the damage they do."

About this time the rabbits became a considerable economic problem and have continued as such to the present day.

"The exports of rabbit products in the period 1900-1946 oscillate between £105,149 and £1,451,301 p.a. but constitute only between 0.30 and 1.88 per cent of the total value of New Zealand exports. On the debit side it was found that the losses in grazing capacity alone heavily outweigh the revenue derived from rabbit exports." (Wodzicki, 1950, p. 141.) This is exclusive of an average of more than £170,000 per annum spent on rabbit control during the period 1943-45.

Red Deer

According to Wodzicki (1950, p. 176) "The main liberations of red deer in New Zealand occurred in the latter half of the nineteenth and the first decade of the present century." The species was immediately successful.

It was not long before deer skins were numerous enough to export but the total value of these exports was insignificant even during the most productive years. For some 15 years prior to the date of Dr. Wodzicki's book (1950) the red deer had been declared "vermin" and had been vigorously controlled by the Department of Internal Affairs. Some serious damage was done to native forests over a period of sixty years. At present Dr. Wodzicki opines that deer are a serious menace in almost any part of their New Zealand habitat.

In addition to red deer, eight other species of Cervidae have been liberated in New Zealand. The black-tailed deer is probably extinct; the moose is decreasing. The other six: fallow deer, Virginia deer, wapiti, Japanese deer and sambar deer are locally distributed and present different economic and ecological problems.

Other Mammals Introduced in New Zealand

These include at least 14 marsupials, 1 hedge hog, 7 carnivores, 6 rodents, 2 leporids, 20 even-toed ungulates, and 2 odd-toed ungulates. Obviously it is impracticable to appraise satisfactorily the long-time effects on their environment without considerable further observation and study. As Dr. Wodzicki puts it in the final paragraph of his book (1950, p. 243): "A complete understanding of the problems at issue should not be expected in the immediate or even in the near future, but by carefully designed and controlled research, and by the closest collaboration between the scientist and those who deal in a practical way with wild life and its depredations, its benefits and its products, many phases of the complicated problems involved are capable of gradual solution."

The New Zealand-American Fiordland Expedition

A notable attempt to secure further definite and detailed information on the present status in New Zealand of the wapiti, the red deer, and some other animals, as well as their environment, vegetational, geological and climatological, was the New Zealand-American Fiordland Expedition, led by Dr. O. J. Murie, and participated in by some fifteen other scientists and field men, mostly New Zealanders, but with a sprinkling of Americans (see Poole, 1951). The publication here cited, which was written and edited by A. L. Poole of the New Zealand Forest Service, together with Dr. Murie and other members of the expedition, is one gratifying result of the effort. Additional reports are anticipated with interest, especially Dr. Murie's more complete report on the wapiti.

DEER IN AUSTRALIA

There were, of course, no deer in Australia originally. But there have been a number of introductions. Bentley (1957) has brought the subject up to date, pointing out that the following species have been imported: red deer, fallow deer, sambar deer, Mollucan rusa, hog deer, axis deer, barasingha, and Japanese sika. In his summary Bentley states: "The peak of importations of deer in Australia took place between 1860 and 1880, the last of record being before 1910. Red deer are plentiful in mountainous terrain at the head of the Brisbane River, are decreasing in South Australia and West Australia, and occur in two concentrations in New South Wales. Fallow deer are well established in Tasmania and in Queensland; hog deer and sambar deer mainly in Victoria, and rusa deer mostly on islands. Axis deer persist in only two places. Wild dogs, including dingo, may possibly be the most important natural enemies of deer. Cattle ticks may have a detrimental effect on them in Queensland. The deer herds are not large and do little damage to timber, much of which is unpalatable to these animals" (1957, p. 225).

SOIL EROSION

In the Introduction to Francis Ratcliffe's book "Flying Fox and Drifting Sand," (Ratcliffe, 1951, p. vii) Julian Huxley points out that soil drift (that is to say, wind erosion) is a creeping cancer of the land; to study it is to be brought face to face with a peril that threatens human settlement and welfare in at least three continents. Huxley comments as follows: "Nor does he [Ratcliffe] fail to comment on some of the country's problems. The reckless cutting and burning of irreplaceable timber; the apparently inevitable decay of Australia's unique fauna in competition with introduced animals, and with the tide of human settlement; the need for real National Parks if something unique is not to disappear from the world—these are some of the topics whose consideration his Queensland experience forced upon him.

"His second investigation, to an account of which the latter part of his book is devoted, was concerned with a problem which is of alarming importance in the U.S.A. and many other parts of the world at the present time—Erosion and Soil Drift. This, as he soon discovered, had "assumed threatening proportions in the more arid pastoral districts, especially in South Australia.' " In his Epilogue, Ratcliffe describes the situation as "nothing less than a battlefield." One interesting point is that *improvement* with its soil development and increased stocking has brought about deterioration (Ratcliffe, 1951, p. 325). He found one of the most extraordinary and discouraging things to be the reluctance of the Australian people to recognize the inevitability of drouth. This peculiar human trait is well exemplified in our own country by the attitude of many of our stockmen.

A somewhat similar view is expressed by McGuire (1939, pp. 300-301): "In the parts of the country already attacked by man, a national effort is needed to save the earth. In whole tracts of South Australia's wheat country, land which was cultivable a few years ago is now slashed by gullies eight and nine feet deep, ten or a dozen feet wide. Presently they will be three, four, ten times as large, unless vegetation is planted. In the saltbush country, the Council for Scientific and Industrial Research estimates that only between one-tenth and a quarter of the original bush-cover now remains. The rate of deterioration accelerates where nothing is being done.

"The dust-bowl and the population problem are Australia's chief dangers. Her national existence hangs upon them, and neither is a matter which can be left to the generations. The crisis in each case is now.

"It is an ominous comment upon the state of the nation that the public remains uninformed and uninterested in both issues."

FIRE

The protection of the native fauna and flora from fire is one of the outstanding problems of the responsible conservation authorities both in New Zealand and Australia. Just as in this country, fire is probably the most important single menace to the forest. "Within a few hours it could undo the work of centuries" (Entrican, 1955, back cover).

During the dry summer of 1896-1897 in North Auckland, in the North Island of New Zealand, a great fire occurred in the Upper Waipoua Forest. At this time, according to a former Kauri bushman and sawmiller, there must have been 50 or more times as much bush in the north as there is today. More recently another bad fire occurred. Widespread indications of a severe fire were observed in the Dandenong Range between Marysville and Melbourne in Victoria. On April 14, 1957, we practically drove through a forest fire briskly burning in the Brindabella Mountains near Canberra, Australian Capital Territory, about which nobody seemed to be much concerned. A little later, on May 3 and 4, we witnessed the woods burning in the night in the Darwin-Humpty Doo region in the Northern Territory. We were informed that the fires are regularly set to get rid of the tall brushy growth and to encourage grass for grazing domestic animals.

Elizabeth Pope, staff member of the Australian Museum in Sydney, writes: "Today (Dec. 2, 1957) is 'black Tuesday'—the worst bushfire damage ever in the history of New South Wales occurred last night, on the Blue Mountains, and 500 people are homeless in Leura, Wentworth Falls and Wallacia. The temperature soared into the 105 degrees F. early in the day and a hot wind, like the breath of a blast furnace, blew the flames across firebreaks (spontaneous combustion of the essential oils in the gum leaves occurred too), and fire would burst forth without an actual spark passing. Homes, churches and schools can be rebuilt but the wildlife suffered terribly. Now all that lovely savannah woodland that you saw around Sydney has been burned. All French's Forest is a charred ruin, most of the Great Dividing Range is burnt between Sydney and Bathurst, and grass fires are raging over in the western grazing lands of New South Wales. Nine-tenths of the fires start through human carelessness too. As a conservationist you would want to weep. The only consolation is that two or three years will see a 'sort' of regeneration in the eucalypt forest and wild flowers. The fauna cannot regenerate to the same extent, I am afraid."

A New Species of Big Game in the Northern Territory

In Northern Territory, east and southeast of Darwin, a company known as "Territory Rice, Limited" is exploring the possibility of rice culture in a large acreage of wetlands lying along the Adelaide River. The company is reported to be financed two-thirds by American, one-third by Australian, capital. A tract of some 2,000 acres has already been planted in the vicinity of Humpty Doo, and 50,000 additional acres are in prospect. Various problems of water supply, weed control, and land levelling have been successfully solved, but a fourth difficulty is not so easy to cope with. For, enter the pied goose, about the same size as our Canada goose, a resident species which, like any sensible grass-consuming species, considers the whole enterprise a contribution to its own particular and private food supply. Although the Commonwealth Scientific and Industrial Research Organization has a highly competent investigator on the job in an attempt to work out a solution of the problem which will be satisfactory at the same time to Territory Rice Limited and to the pied goose, no easy answer is forthcoming. In company with Stephen Davies of the C. S. I. R. O. the writer flew the area. A million or more acres of lands along the Adelaide River seem to be promising for rice production, provided the goose problem can be solved.

A considerable variety of wildlife occurs in this part of the Northern Territory, including kangaroos, wallabies, a number of birds (among them brolgas, jabirus, the blue-winged kookaburra, peregrine falcon, white-necked heron, galahs, straw-necked ibis, white ibis, royal spoonbill, bar-shouldered dove, fork-tailed kite, lotus bird, plumed tree duck, pied heron, etc.), and, conspicuously, a large species of monitor lizard (*Varanus* sp.), which, to an American, looks like an undersized dragon.

Along the marsh-bordered course of the Adelaide River were hundreds of water buffalos. Those were originally imported into the Northern Territory to add to the domestic animal power of the early settlers. The white man was unable to handle the huge and truculent beasts, however, so the effort to utilize them in agriculture was given up, and the imported animals turned loose. They have increased in numbers. In a 250-mile flight by plane we counted more than 1,000 of the huge beasts. In Thailand (Siam) and other Asian localities where the animals are used extensively in farming, they are regularly handled by ten- or twelve-year-old boys. In Northern Territory the buffalo is now regarded as a game species. If any of you wishes to bag a buffalo, I suggest you write the Territorial Government, Darwin, Northern Territory, Australia, and inquire about the regulations up to date.

NATIONAL PARKS

While in Christchurch, South Island, second largest city in New Zealand, we fortunately made the acquaintance of Dr. Lance McCaskill, of Lincoln Agricultural College. Dr. McCaskill is a one-man conservation movement all by himself. His account of the national park movement in New Zealand was most informative.

On April 1, 1953, there was enacted the National Parks Act, which "... for the first time recognized the real importance of the parks and made provision for their perpetuation and wise use." A National Parks Authority was set up, with authority to

"Preserve in perpetuity as National Parks, for the benefit and enjoyment of the public, areas of New Zealand that contain scenery of such distinctive quality or natural features so beautiful or unique that their preservation is in the national interest." (McCaskill, 1956, p 21).

Americans may well be proud that one of their own leaders, Dr. Olaus J. Murie, Director of the Wilderness Society, secured the inclusion in the New Zealand National Parks Act of a provision for the preservation of wilderness areas. Under the authority granted by this provision, the board in charge of a park, with the consent of the National Parks Authority, may set aside any area of the park as a wilderness area. In such wilderness area no buildings, ski tows, or other apparatus may be erected; no horses or other animals or vehicles may be allowed; and no roads, tracks or trails constructed.

The New Zealand system boasts no less than eight parks with a total area of some 3,800,000 acres, nearly 6 per cent of the total area of the country. This is perhaps a larger proportion of national area allotted to these great national scenic reservations than in any other country. The corresponding percentage for the United States is less than one per cent!

Another item of which Americans may well be proud is that McCaskill and, indeed, the National Parks Authority of New Zealand give credit for the initiation of their entire national park movement to that far-sighted group of American explorers who, at their camp in what is now Yellowstone Park in the United States about 1870, anticipated the need for a chain of great natural reservations, and sufficiently caught public attention so that ultimately the national park movement resulted. It is of interest that the New Zealanders may be doing better than we in carrying out the spirit of the Yellowstone proposals.

OFFICIAL EFFORTS FOR CONSERVATION EDUCATION

Both the general public and its official representatives in New Zealand and Australia appear to be interested in conservation. While our period of observation was all too short to permit us accurately to appraise the situation, we derived the general impression that the public reaction to the problems involved is about the same. While the victory for conservation is far from won, in either place, still there is hope!

There are factors favoring and opposing conservation in the two areas. The New Zealand and Australian region is favored by having fewer people per square mile than is the case in the United States. Indeed, our biggest complicating factor in conservation administration may well be the constantly worsening land-man ratio, with a more and more congested human population threatening the ultimate elimination of every forest, all our wildlife, and every sample of our natural areas. The Australasians face a difficult problem in the ignorance and apathy not only of the New Australians but many of the long-time residents regarding their remarkable fauna and flora, coupled with the obviously defenseless and unaggressive characteristics of their animals.

There are many signs that some, at least, of the Australians and New Zealanders are facing their conservation problems with a high sense of responsibility, determination, and intelligence.

As in the United States, there is a tendency to scatter authority over many agencies, where perhaps greater efficiency might be secured by a concentration in fewer administrative units. Wodzicki (1950, p. 16) points out that, in New Zealand, wildlife management is exercised by the following: Department of Agriculture, State Forest Service, Department of Internal Affairs, Department of Marine, Lands and Survey, Public Works (Soil Conservation), Tourist and Health Resorts, various Park and Domain Boards, 27 Acclimatisation Societies, a number of Rabbit Boards and the Rabbit Destruction Council. Of these the Departments of Agriculture, State Forest Service, Internal Affairs and Marine operate research divisions, although these are not necessarily connected with wildlife problems. In a later paper Riney (1952) extends this list considerably. Assuredly, as in the U. S. A., there is no lack of organizations! Subsequently to the publication of Dr. Wodzicki's book an Animal Ecology Section was organized in the Department of Scientific and Industrial Research, with Dr. Wodzicki in charge, an encouraging development, which can mean much to conservation in the Commonwealth.

Officials of the Wildlife Division of the Department of Internal Affairs whom I met, as well as those in the Animal Ecology section of the Department of Scientific and Industrial Research, and the New Zealand Forest Service, seemed highly intelligent, dedicated and competent men, fully worthy of responsibility for the important resources with which they are concerned.

Among other agencies concerned those representing the sportsmen, the farmers, foresters and other land managers, the tramping clubs, and especially the universities and museums would seem to deserve special mention.

In Australia a Wildlife Survey Section has been formed in the Commonwealth Scientific and Industrial Research Organization, under the directorship of Francis N. Ratcliffe, who is largely responsible for the practical solution of the rabbit problem in that continent. A staff of highly competent wildlife research workers has been gathered together, and the fund of information being accumulated will be of the utmost value in conservation efforts as well as to other phases of science both basic and applied. In order to disseminate the findings more effectively a new periodical "C.S.I.R.O. Wildlife Research" has been initiated. This will be issued as material becomes available. It will be devoted mainly to mammal and bird ecology, control and conservation, and related subjects. The four numbers which have so far appeared give every evidence of a high standard of work and publication.

From our reading of Australian and New Zealand newspapers, it appears that the press should, and actually will, be of the utmost assistance in bringing the needs for conservation continuously to the attention of the general public. Then, too, such publications as Walk-about (the Australian Geographical Magazine) and the Australian Women's Weekly can give strong support to the entire movement.

More important than anything else is the character and caliber of the interested individuals. Whether in governmental bureaus, the press, or in private organizations, or indeed, in any organization at all, Riney's (1952, pp. 26-32) quotation from Aldo Leopold (Trans. 17th Amer. Game Conf., 1930, pp. 281-283) is highly appropriate:

"Experience seems to show that no particular form of organization has any inherent merit in and of itself. Merit lies only in personnel, and any particular form is good or bad only in so far as it provides a good or bad mechanism for the personnel to work with."

One last thought. The balance of travel and trade between Australia and New Zealand on the one hand and the United States on the other is such that the Australians cannot use their money for trips to the United States. To my mind, an expanded interchange of persons would be wonderfully fruitful. Many more Americans should go to New Zealand and Australia. In the opposite direction, American institutions should consider the possibility of short term employment of Australians and New Zealanders on leave, so as to help them visit America. The resultant cross-fertilization of ideas, broader acquaintance, and international cooperation, doubtless would be worth far more than the trouble and cost.

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DISCUSSION

MR. CLARENCE BILLINGS [Missouri Conservation Commission, Springfield, Mo.]: What are they doing in the schools to help meet these problems?

DR. TAYLOR: I don't know in detail. We weren't able to examine the school situation to any extent. But with the inspiration they are having from a number of leaders and the government and private organizations in Australia, I am sure they are doing a good job in the schools so far as they can. One of the activities which impressed us a great deal was the activity of the tramping club, the youth hostel associations.

MODERATOR CAPPS: You made this statement: "Both Australians and New Zealanders are facing their conservation problems with a high sense of responsibility, determination and intelligence. As with us, there is a tendency to scatter the authority and responsibility in this field over too many agencies when perhaps fewer could do better. Seemingly most promising of all official efforts are the specific wildlife agencies in the two nations." Would you comment on that statement?

DR. TAYLOR: In Australia, they have only recently set up the Wildlife Survey Section in the Commonwealth Scientific and Industrial Research Organization. This is under Mr. Ratcliffe, whom some of you know as the man who has largely solved the rabbit problem in Australia through the introduction of myxomatosis. That section is patterned after our own Fish and Wildlife Service to a great extent, and a group of excellent technical people, mostly trained in England, are there working on problems of wildlife management from a very broad standpoint.

In New Zealand, there are several agencies devoted to something like the same objective. One is the animal ecology department in what they call the Department of Scientific and Industrial Research. That is under Dr. Wodzicki, who is a dedicated man working on the problem of how best to relate the exotics to the native fauna and to solve the many problems that resulted from the unusual number of introductions.

Then, in the Department of Internal Affairs, they have a Wildlife Section which also is working. In that case, not only on research are they working, but on direct control efforts where those are called for. They are going at the problem with high intelligence and with enthusiasm. At the same time, the obstacles are tremendous. There is apathy on the part of the public there, just as there is here. that is almost insurmountable and there is, of course, the same commercial type of interest which would take up land, sell it off at a profit and exploit it to the full and then go on somewhere else and do the same thing again without regard whatever for future generations or the welfare of the people, present or future.

MODERATOR CAPPS: Thank you.

DR. E. LAURENCE PALMER [American Nature Association and Cornell University]: I would like to comment on what has been done in New Zealand. I have not been in Australia recently. I was there for four months in 1949, but I can't speak for what has happened since. But in the schools of New Zealand, there is available a finer literature than the average for school use that is ordinarily available in most of our states. They have had men in their museums and others such as you have suggested, who have joined together and produced literature interpretative of their natural history, which is excellent, and worth looking at by anybody.

I was impressed by the fact that in elementary schools there are more men teaching than here. I went into a rural school in the southern part of New Zealand. I was just observing. The teacher picked from whatever he found, material which I am quite certain that the average agent in America or New York State would have been completely stumped on. And yet he turned those things into directly satisfactory educational exercises. I was very much impressed with the versatility of the people. In each of the units that you might compare to a county, there is a Supervisor of Natural History whose responsibility is to the District Supervisors who in turn are responsible to larger supervised groups.

I am very much impressed with what they have done in New Zealand.

DISCUSSION LEADER CAPPS: I believe Dr. Taylor was referring to the technical aspects of conservation education. I was thinking of the education of the general public, which I believe is very important, and Dr. Palmer has indicated that that is being taken care of.

JUNIOR COLLEGES WORK IN CONSERVATION EDUCATION, TOO!

PAUL A. WHITE

Nichols Junior College, Dudley, Mass.

The theme, "Conservation in an Expanding Economy" seems to have been tailor-made for the new Nichols Junior College program in forestry and conservation. It is not that junior college work in these fields is new. Many excellent two-year programs in forestry can be cited. However, the idea of a school of Business Administration starting such a program is, I believe, new, and probably to some, rather startling. We at Nichols are engaged in an undertaking which should turn out men exceptionally well prepared to fit into an expanding economy.

Historically, the story of the Nichols program is not a long one. In 1954, Colonel James L. Conrad, president of the college, became very interested in doing something in the conservation field. Friends of the college, Richard Potter of the Worcester Natural History Society; Raymond Kenney, Director of the Massachusetts State Division of Forests and Parks; and F. H. Daniels, a member of the Board of Trustees of the college, encouraged this move. They felt that the conservation field as a whole needed men with business training as well as technical training. With their encouragement, Colonel Conrad established a program which led to the degree of Associate in Business Administration with a major in Forestry. For 2 years the enrollment was very small and no full-time instructor was employed. In June of 1956, I was employed to take over the forestry and conservation program. The program that has evolved since that time, and the facilities with which I work, are the things I want to discuss at some length.

First, I should say, that my own experience in the forestry and conservation fields has led me to some fairly definite conclusions about adequate training. In more than a single instance, even a modicum of business training and knowledge would have saved many kilowatts of electricity for the "midnight lamp." To back up my own feelings, the March 1957 issue of *American Forests,* in the article "Can He Grow with Our Organization?" emphasizes the need of business training. This article, or rather series of comments from employers of forestry men, mentions business administration or some phase of business at least eight times. Along this same line, any conservationist reading Doane, 1957, *World Balance Sheet,* would find that economic and business knowledge was required. These things, plus other comments and material mentioning items such as "cost-awareness" convince me that we are on the right track.

Now, as to our program and facilities at Nichols Junior College.

We are able, in two years, to qualify men for the ABA degree and at the same time cover some of the basic forestry and conservation courses. All graduates of Nichols, including foresters, take one year of business procedures, accounting, public speaking, business law, and economics, plus two years of English.

In addition to the above, freshman foresters take one semester of business mathematics, one semester of zoology, one semester of forest mathematics, and one year of economic resources. Freshmen carry a course load of 19 hours the first semester and 16 hours the second. Senior foresters carry a minimum course load of 18 hours per semester. I would like to explain, briefly, the freshman courses.

In economic resources the material covers the natural, human and social resources of the world. Each of these is discussed in the light of modern needs and demands. The second semester of this course is devoted to economic geography. Quite a bit of emphasis is placed on climatology and its effect on the distribution of both man and his resources.

The zoology course is a standard collegiate semester course. Laboratory is required with standard dissections of four specimens.

The forestry mathematics is a quick, capsule review of some very basic algebra and geometry and an introduction to the elementary calculations required in forest mensuration. I might add here that, in common with many others, I find mathematics a definite weak spot with today's students.

Physical plant at the college includes more than 200 acres; adequate clasroom space, plus approximately 25 acres of wooded and open area specifically set aside for field work in both forestry and wildlife. There is also a small pond and brook on the area which offer some possibilities for fisheries work.

We have a room for a small animal laboratory where at present there are experiments in nutrition, genetics, and pheasant breeding being carried on.

This spring a small forest nursery will be started and some greenhouse and field experiments on the effects of fertilizers on forest soils and forest tree species will be underway shortly.

Four permanent sample plots were established in the forest area last spring and work on them will continue. One thinning has been made, two others are marked, and one plot is an experimental area for thinning with chemical killers and debarkers.

We are also developing a small zoo. At present this consists of some exotic pheasants and three black fallow deer. We hope that this spring will bring an increase in our deer herd.

Between their two years at Nichols, the foresters are required to spend eight weeks at our summer school in Rutland, Mass. Here we have excellent facilities for field work in all of the conservation fields. The tract where our buildings are located is approximately 275 acres. This includes wooded areas, a pond, and some open land. Our buildings are all permanent and total 16 in number. There are eight cabins for students, four faculty and guest cabins, the Directors' lodge, the kitchen and dining hall (capacity 60 people) and two laboratory-classroom buildings. In addition to this base tract, there is a forest of nearly 800 acres near the Harvard Forest in Petersham belonging to the summer school.

One of the most noteworthy aspects of this summer school should be mentioned at this time. Eight years ago the Worcester Natural History Society started the F. H. Daniels School of Forestry and Conservation at Rutland. This summer school was designed for high school age students who showed a sincere interest in these fields. When the college started their program, the tie-in was obvious. The summer school now consists of two sections, the collegiate and the high school. The Nichols College instructor is over-all director of the school.

With the area and the facilities available at this summer school we are able to offer a wide range of experiences for the students of both groups. For the Nichols men there is area enough for extensive cruising practice; fairly large scale mapping exercises; and censusing practice.

A forest nursery is maintained, and last summer the Nichols men laid out an irrigation system for it. Also laid out by the Nichols men was a run-off plot which should be completed this summer.

This coming summer the Nichols men will have a real job in establishing a boundary and initial survey for the 800-acre area mentioned above. This same exercise will give an opportunity for some experience in real field living. A fire tower is also a distinct possibility for next year.

It is also possible, by judicial juggling of instructors, to give the Nichols men a smattering of entomology and botany during this eight-week period.

When they return to Nichols for their second and senior year, the forestry majors are given an opportunity for some small amount of specialization. In addition to the business courses (law, economics, and English), they may choose a major in forest management, wildlife management, recreational management, or forestry and business administration. The first semester for all majors is the same; forest mensuration, silvics, and wildlife management I.

The forest mensuration course, along with the freshman work and the summer practice, allows two full semesters plus, in this very important field. Emphasis in all courses, and particularly in this one, is placed on working tools. Silvics is, of course, a basic course for both forestry majors and wildlife men. The wildlife course is based on Leopold and attempts to give a basic understanding in game mechanics.

For those that major in forest management the second semester consists of silviculture, harvesting and forest management. These are standard courses, using standard texts in the field. In connection with forest management I would like to add a comment. One of the texts in this field mentions on page one that this field consists of work in the social and business aspects as well as the technical. Of the ten business and social subjects listed, Nichols men now receive training in four.

The wildlife majors, in their second semester, take silviculture, wildlife II and III. Wildlife II is a course in techniques while III covers mammalogy and ornithology. In connection with mammalogy and ornithology, detailed dissection work is required in both fields. Training will also be given in the preparation of specimens.

The recreation and forestry business majors interject a course in recreational management or one in marketing or management in place of the Wildlife I and Harvesting or other wildlife courses. The complete curriculum of both the collegiate year and the summer school is included here as Appendix A.

Enrollment has shown a steady increase. The school year 1956-57 started with 5 seniors and 20 freshmen. This school year found 13 seniors returning and 28 freshmen enrolled. At the present time the two classes total 38 (13 seniors and 25 freshmen). Enrollment for the next few years will be held at thirty per class.

Most of the men enrolling in the forestry and conservation program show an intense interest in the work and in their chosen field. This interest, and its academic effect, can best be shown by the semester results just posted. Checking the list of students receiving academic commendation we find that foresters have 62 per cent of their freshman class on the list, while the business students have 39 per cent. Results like this augur well, not only for the professions of forestry and wildlife, but we think, for our program at Nichols. Many of these present freshmen are already seriously checking senior colleges for opportunities to pursue their interest and studies further.

Of the one graduating class of five, one has gone on to a senior college. He was actually accepted at two accredited forestry schools. The school of his choice gave him 92 out of a required 190 credits for graduation. Another of the first five graduates is doing very well in his own landscaping-forest nursery business.

One other aspect of the Nichols program is worthy of mention. This is the Advisory Council group.

For many years Nichols has had an Advisory Council which works very closely with the school in curriculum establishment and counseling the boys. One of the developments of this work has been the holding, twice a year, of Advisory Council Day at the college. On these days prominent business men, many Nichols' graduates, assemble in various panels at the school and spend the day discussing the many aspects of business with the students. These are free-flowing question and answer sessions. Part of the spring session is devoted to private conference with senior students. This is in no way meant as a job seeking or job procurement device. It is, however, an excellent opportunity for the student to come into close contact with men engaged in fields of his interest.

We are now in the process of building such an advisory group for the forestry and conservation students. At present we have five men who have taken an active part in the one advisory day held this year, and several others who have indicated their willingness to participate in the future. To date these men represent state forestry, lumberyard dealers, mill and woods workers, and private conservation and natural history fields. For our next session I hope to add wildlife management and soils management.

The students are not the only ones that profit from this association. We in charge of the program receive much direct and indirect help from these men who are professionally engaged in some part of the conservation field.

There are many interesting sidelights and side developments of our program. One that is most interesting to me and should be to this panel is the high interest among the students in conservation education as such. Their interest has reached such a peak that on their own they have begun work on the publication of a conservation education magazine. They have arranged for printing and for articles (some of those in attendance here may have been approached on this score) and are planning their first edition for June, 1958. I think it important to emphasize here that this is not a class exercise for which they will receive credit. I should also like to point out that all those who have been approached for articles have responded most willingly. Both things speak well for conservation.

The magazine is one of the activities now being handled by NICON (Nichols Conservationists). This club is active in sponsoring science films, and is planning for such outdoor activities as a field archery range and participation in the Woodsman's Field Day this spring. The club has also drawn up the rules and scoring device for an annual award to be made by the club to the outstanding senior each year.

In summary, we at Nichols feel that we are making a contribution to conservation in several ways.

First, by adding basic business training to the technical aspects our men will be better equipped to tackle the complexities of conservation business.

A Nichols man in the field will be a better field man for knowing the office end of the business. A Nichols man in the office will know the problems and scope of field work. They are armed, so as to speak, with two strings to their bow.

Second, we are filling a definite need for many of our students in giving them a chance to examine and evaluate their interest in these fields.

Third, we are adding a little each year to the desirable "crop" at senior colleges with our transfer students.

Last, but certainly not least, we are contributing our bit to the need for better understanding and knowledge in the all-important field of conservation.

APPENDIX A

FORESTRY and CONSERVATION

Freshman Year

1st Semester		*2nd Semester*	
Business Procedures	3	Business Procedures	3
Accounting	3	Accounting	3
Business Mathematics	3	Forestry Mathematics	3
English	3	English	3
Public Speaking	1	Economic Resources	3
Economic Resources	3	Public Speaking	1
Zoology	3		
	19		**16**

APPENDIX A

FORESTRY and CONSERVATION

Senior Year

1st Semester		*2nd Semester*	
Forest Management Curriculum			
Silvics	3	Silviculture	3
Mensuration	3	Harvesting	3
Wildlife Management I	3	Forest Management	3
Wildlife Management Curriculum			
Silvics	3	Silviculture	3
Mensuration	3	Wildlife Management II	3
Wildlife Management I	3	Wildlife Management III	3
Recreational Management Curriculum			
Silvics	3	Silviculture	3
Mensuration	3	Wildlife Management II	3
Wildlife Management I	3	Recreational Management	3
Forestry and Business Administration Curriculum			
Silvics	3	Silviculture	3
Mensuration	3	Forest Management	3

Instead of Wildlife Management, elect *Marketing, Finance, Management,* or other business courses that fit your particular interest.

SENIORS: Required 9 hours—Business Law, English, Economics, and Ethics-News Analysis.

APPENDIX A

FORESTRY and CONSERVATION

SUMMER CAMP

(8 weeks)

Botany I	6 hours/week	3
Surveying and Mapping	6 hours/week	3
Forest Entomology	10 hours	1
Wildlife Management	6 hours/week	3
Timber Cruising	100 hours	5
Nursery Work	25 hours	
Report	10 hours research	
Woods Work	25 hours	
Examinations	10 hours	
	Total Hours (credit)	15

DISCUSSION

DISCUSSION LEADER CAPPS: I would like to ask one question and not in criticism of your program. You have 38 students this year in your conservation course. What is the total enrollment of Nichols Junior College?

DR. WHITE: The total enrollment is about three hundred and fifty.

DISCUSSION LEADER CAPPS: What training in conservation do those other students receive?

DR. WHITE: I was afraid somebody would ask that. At the moment, I have only been able to get economic resources, which is a year's course, and a general course like the one Dr. Wagar mentioned, put on the elective list. I hope some day to make it a required course for all business majors, but at present it is on the elective list.

MR. ROLLIN BAKER [Michigan State University, East Lansing]: This is an interesting paper and it seems that if some kind soul would provide money for reprints of this paper and send them to some of the other Junior Colleges around the country, it might be elevating to them.

NATURAL AREAS AND EDUCATION

PAUL BRUCE DOWLING

Nature Conservancy, St. Louis, Missouri

In this age when the three "R's" would appear to mean rockets, reactors and rock and roll, have we failed to provide the basic fundamentals for "one world" living? Might it be also that we have failed to maintain a harmonious relationship between the student and his environment: in short, have both we and our youngsters grown unnatural? Let's look for some way in which humans as ecological beings might find their way back into a natural environment—natural areas for natural living might be one answer. With a shift to urban living, natural areas would seem as important to our well being as language is to our culture and vitamins to our physical growth.

My intention is not to limit the following discussion to those open areas contiguous to public school buildings but to discuss various land types and their uses in both formal and informal education.

But first let's examine different kinds of natural areas. Here natural areas are charted (Fig. 1), not on an absolute scientific scale, but schismatically on a parabolic curve in order of their relative aesthetic value, number and use. Any kind of urban open area such as a dump or vacant lot might be found on the lower end, in the middle might be natural areas for schools, and on the upper end would, of course, be wilderness. Many will find fault in the relative juxtaposition of the different kinds of areas—but surely no one will place the value of dumps ahead of wilderness. That many of the values illustrated by these land types (different land uses) might be possible within one area should also be recognized. The areas to the upper end of the curve are for the most part preserved, while those to the lower and of the curve are MAN-aged. Natural areas for schools fall in between natural and managed areas. In most cases a school natural area could be a multiple use area containing features of both land preservation and land-use. The trend toward consolidated schools in the post war years has allowed for considerable acreages being acquired for school grounds. The use of these acres, for the most part, has been taken up only with formal landscaping and athletic facilities. In a number of outstanding instances, however, schools have used lands for agricultural purposes, school forests, natural outdoor laboratories and school camps. Unfortunately, the public secondary schools now carrying on an outstanding natural area program would, I am sure, fall below the one per cent level. With the pressing problems of increased enrollment, limited physical plants, scarcity of qualified teachers, we find the idea of natural areas for schools falling well behind in the minds of those who administer our school activities. It is necessary that school administrators be shown that natural areas for schools are more than just frosting on the cake.

An astute science or biology teacher can adapt his outdoor teaching to the most crowded section of the largest city and use the poorest

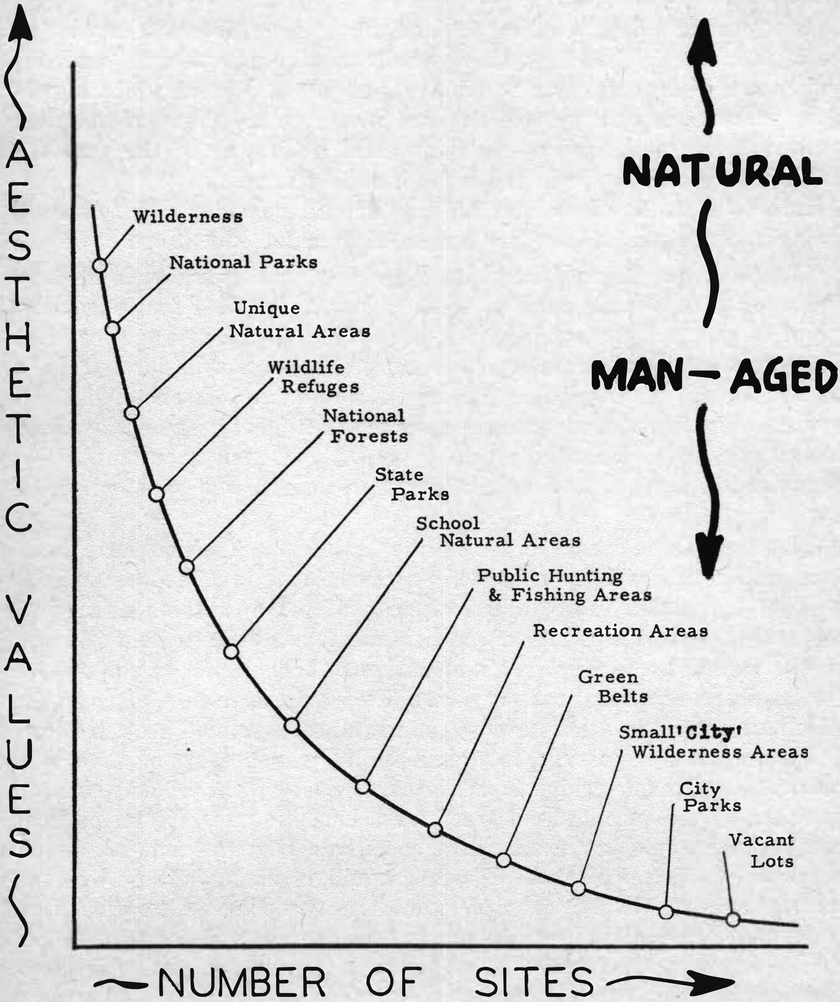

Fig. 1. A provisional listing of natural areas by aesthetic value, number and use.

kind of open area to good advantage. Unfortunately, this is the exception, not the rule. We should, therefore, think of ways to set up natural area facilities which will be used by the average, or even the pressed-into-service science and biology teachers; by outstanding teachers of related subjects; and, also by teachers in the lower grades. Yes, just as children in classrooms visit large airports, civic buildings and historical sites, so should regular visits to natural areas be made possible for every youngster.

Is it just idle daydreaming to hope for a large diverse campus for each and every school? Is the goal of acquiring a natural area for your town or community a possibility, not just a Utopian idea? Maybe fifty years from now we will think it wrong to move out of our own ruined urban community—as disgraceful as it was in the past for farmers to move to virgin lands from ruined farms.

Interested individuals and officials should consider the following items in attempting to acquire a natural area for education:

(1) *Location:* The comment is often heard that a school is already too *small* for its enrollment as soon as it is finished. From our viewpoint, a greater shortcoming, if it is possible, is the average location. Rarely is a school, even a rural consolidated school, located in a natural scenic environment. The rigid boundaries of school districts and municipalities often prevent the use of an ideal area outside these imaginary lines. This limitation to growth in many communities—for parks, schools, or any civic betterment, poses a real problem which must be rectified.

In some of the larger cities in the East estates which have been held in longtime private ownership often become tax burdens on subsequent heirs, and these folks look around for a suitable agency to maintain the land in the same condition as it has been preserved while in the family ownership. This situation offers specific opportunities for land preservation in many cities. These sites are now often in an excellent central location because the town has expanded around them. They are often accessible to quick public transportation. The best natural area is one which is an integral part of the school campus, attached to the specific land tract the school occupies. Next, natural areas which could serve several schools, a school district, or, in an extreme case, several school districts would be an advantage over no natural area at all. An example would be a wooded reservation near St. Louis, "Rockwood," which serves tens of thousands of school children every year and draws classes from a population of two million. But just imagine the numbers of children that never get a chance at just one outdoor learning experience because of time and transportation difficulties, school regulations, and just "lazy" teachers. One such area far from the city is not enough for St. Louis or any other municipality. Would a municipality like St. Louis have only *one* church, *one* movie house or *one* barroom?

Roughly dissected lands or stream valleys, often the last sites to become developed when communities are expanding, offer good sites for school studies. It is amazing that even inside the heart of large cities relatively undisturbed sites can be found. Measuring transportation costs alone, the use of a natural area outside of town versus use of an area next to the school, might not the prorated acquisition costs over a period of years be much lower?

(2) *Acquisition:* Many civic agencies (park boards, city planners, conservation agencies, school boards) welcome constructive ideas and proposals if they are realistic and contain factual and enlightened data, this being a change of pace from a demanding, inconsiderate, or a disinterested public. Thus, even though acquisition should be left to the experts, such data as size of area, topography, unique natural features, location, plat map showing ownership, estimated value or cost of project and proposed land-use plan will go a long way in influencing those that hold the purse strings. In other words, you need a concrete proposal or prospectus.

Even some portion of a newly acquired school site might be worth saving from the leveling bulldozer—even second growth woodland, a rocky outcrop or an old field is worth studying.

There often seems to be the dilemma in the acquisition of public lands that, once the money is available, land prices rocket out of reach. Similarly, when money is not available, ideal sites are often lost through lack of funds. Therefore, private support through outright purchase or gifts of land to local school boards might be the only solution. This means both the donor and the recipient should be sold on the value of the natural area program. Government agencies have long been known to look a gift horse in the mouth because they did not know what to do with a specific bequest of land or because they were limited by some superficial policy. If given local encouragement, a far-sighted, flexible schoolboard or a superintendent of schools might help find a way to acquire a school natural area.

With quality the keynote for the future even such unthinkable prospects as real estate firms might consider it a wise investment to set up a large tract with a natural area for a public school.

(3) *Flexibility:* Those working toward a school natural area must be adaptable in their thinking and attempt to sell the natural area idea on the broadest possible basis. There might be included any aspect

from lakes or ponds to a school forest, a school farm, arboretum, or even a natural outdoor amphitheatre—with special emphasis on an interest of the local potentate—either school official or politico! Yes, even athletes from cross country runners to field archers could use such an area. All in all, however, the natural area proponents should aim for a natural rather than a formal landscape or land-use plan. Their willingness to compromise should not be at the cost of appeasement to great or strong interests that seek to destroy naturalness or natural values. The evolution of parks toward playgrounds is unfortunate, so a wise administrator often provides a recreation type facility on the periphery of the natural area.

(4) *Maintenance:* The larger the variety of multiple uses carried out on a school ground, the higher the maintenance cost. Again, a danger of the purely American tendency to attach the greatest significance to the costliest programs should not be allowed to prejudge the value of natural area activities. There is an exaggerated concern on the part of school administrators to consider maintenance costs the biggest problem, and it should be pointed out that these small wilderness type areas can be wisely used at a minimum of future cost. Nominal costs and prudent expenditures can provide sufficient funds for school forests and arboretums, school farms and outdoor "nature" laboratories. The cost of trails, signs, and, at best, a small museum for a natural area will be less than that of formal outdoor facilities. Costs can be offset by by-products—say from school forests in the form of firewood or even saw logs. Natural areas that are set up privately to accommodate school camps or other groups often are a money-making proposition. On the long term basis, a small school natural area might be administered by the local park board and the routine chores be taken over through special agreements if this is desirable.

(5) *Perpetuation:* This is the biggest task for those interested in natural areas for schools to face—far bigger than the problem of acquisition. Many groups will seek to make their specific interest the dominant activity and will attempt to usurp the rights of other users. The trend toward the lowest common denominator, the mediocre, is a common problem in multiple-use management of public lands. Some communities through forthright and farsighted planners and administrators have withstood encroachments of even such popular causes as highways, football stadiums, and even atomic energy plants. The outstanding case in point is the Cook County Forest Preserve system and, on the debit side is the loss of a natural area on the campus of The Pennsylvania State University to a memorial chapel.

Yes, natural areas should be available for use in formal school training on all grade levels—just as important, however, is their use in informal training. Often the greatest successes in the training of youngsters in out-of-door lore are accomplished by such groups as Boy Scouts, Girl Scouts, 4-H Clubs, church groups and family groups on community outings.

I might note here that the Nature Conservancy has published materials which are available to aid individuals or groups in working for a school natural area.

Then, too, a natural area is no better than the leader or teacher. Dynamic, dedicated people should be found to continue the process of nature education, which has evolved in this country over many years, into the realm of conservation education and modern science teaching. It is not enough to learn the names and numbers and sizes and songs of birds. Not enough to describe, list and enjoy flowers. We must teach specifically those natural processes by which living communities exist—in short, teach basic ecology—the new natural history. A boy doesn't have to be taught about an earthworm or its home, the hole it crawled out of—he is very familiar with this animal and its wise-use as fish bait. But the role of the worm in the process of soil building, its role in its soil community are subtle values which must be brought out through field observations.

Most of us have had the rare opportunity of following the gifted field trip leaders of present and past generations. We have learned much from their teachings. But new techniques, new visual aids, new outdoor "living museum" materials must be developed for future generations. The Missouri Conservation Commission at the Busch Wildlife Area developed a series of five conservation trails on soil, farm, wildlife, forest conservation and water conservation. These trails were designed vividly to depict to groups ranging from the age of 7 or 8 to college graduate students some of the natural processes and principles upon which good land management is and should be based.

It should be a part of the wildlife manager's duties to hold field sessions with sportsmen's groups explaining the principles as well as the specific techniques upon which a wildlife management plan is based. This could be a Conservation short-course.

Specific projects should be undertaken. A good example of one is an ingenious project carried out in a portion of the Ozarks by the Missouri Conservation Commission personnel. This is the distribution of trees to grade-school children during the Arbor Day season. True, the 50 or 100 trees that each individual student planted on his farm will not contribute much in the way of forest trees for the future, but these few trees planted on the back hillside often restrained the parents from burning off that same forest land, previously a common local practice. Natural areas for the future should be set up in a plan calculated to perpetuate them from generation to generation. Too often areas persist only because of the interest and energies of one person—if he leaves, no one is sought out to carry on a natural area program. Some short-sighted, so-called administrators often feel compelled to change the use of an area to one of a seemingly more popular nature.

With planning the keynote for the future the role of natural areas would seem assured. Such things as enlightened zoning on public lands (city and county parks, wildlife areas, recreational areas), and the use of restrictions in subdivisions, and even balanced planning on college lands are encouraging. Private camps and resorts have even come to the point of designating specific areas for specific outdoor activities. The sooner multiple use is *defined* and management efforts *refined,* the sooner will a quality program on all outdoor lands be developed. Ecological planning will be the mainstay of the land manager of the future. What can you do, how can you preserve natural areas values for your school and community? Although classroom education is supposedly in the hands of qualified people, it is time to take the class out-of-doors. It is time that everyone feels some compulsion to offer his special talents to improve the environment of his local community instead of running off and leaving it. It is time to bring the values of a natural area education to the attention of citizens and teachers alike if these values are not recognized in your community. It might take a selling job, but individual effort to preserve some areas for the future is one of your rights, privileges and duties in a democracy. Without your strong personal sense of responsibility, actual natural land preservation will diminish, and what a dim future we will face in a land of concrete and golf greens.

DISCUSSION

Chairman Wade: I have one remark I would like to make about Bruce's paper. I spent a number of years at Dartmouth College as a naturalist and I watched on this magnificent campus and its surrounding area, the gradual disappearance of work areas that had been used by various department heads, particularly the botanists. One by one, these remarkable teaching sites that were used over a good many years disappeared. What I am getting at is that somehow we have to learn how to catalog these particular things in the environment in which we teach and make it be known that they are real assets to our teaching and then we might we able to save a good many more of these small teaching sites which in the total aggregate are natural areas.

THE FUTURE OF WILDLIFE IN NORTHERN MEXICO—A PROBLEM IN CONSERVATION EDUCATION

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The states that form the northern part of the Republic of México are strewn with a mixture of hot and arid deserts, plains and rugged mountains. While most American tourists feel that they must tolerate the region long enough to cross it hurriedly on their way south to favored vacation retreats, an ever increasing number of agricultural and business interests are being attracted to northern México by the area's natural resources. The people there are prospering; their future seems bright. The wildlife is not prospering; if present attitudes and practices of the people continue, its future will be far from bright.

Today, northern México is producing more farm and ranch products than formerly. Since 1920, and especially after 1940, an increasing number of wells have been dug and dams constructed across streams and arroyos, augmenting the water available for irrigation and for livestock. This additional water supply has transformed areas that formerly were parched and covered with scattered desert shrub into populous communities where cotton, corn and other crops are grown or where ranching establishments flourish. Some areas still await development where lush, grassy highlands, now ungrazed by domestic stock, merely need supplies of drinking water at strategic places. In addition, many streams and arroyos have natural dam sites where water could be stored for irrigating fertile soils nearby.

Pressures on existing wildlife seem likely to increase. Looking ahead, we may assume that the human population will increase as the land is made more productive. Space available for game and other wildlife will be reduced or decline in quality as a result of heavy grazing pressure from domestic livestock and other practices. Hunting of game will surely increase, because there will be more hunters who will have easier access to the region via new and improved roads and air strips. Land values will increase. Areas desirable for wildlife preserves will soon become more costly and perhaps even unobtainable with the modest funds generally available from private and public sources. With wildlife resources in the area already declining, their future is certainly in peril.

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DESCRIPTION OF THE AREA

Northern México (see Figure 1) consists of a broad central region of arid highlands (known as the Mesa del Norte or the Chihuahuan Desert) separated by escarpments (the Sierra Madre Occidental on the west and the Sierra Madre Oriental on the east) from coastal lowlands (the Sonoran Desert on the west and the Gulf Coastal Plain on the east). Tropical plants and animals, that have spread northward on the coastal lowlands, especially on the more humid Gulf Coastal Plain, and on the seaward exposures of the front ranges, are excluded generally from the Mesa del Norte except in moist situations along the few streams that drain the region. Otherwise, the principal habitats for wildlife are: (1) desert shrub, where the annual rainfall may be less than 10 inches; (2) grasslands on higher plains; and (3) mountainous areas on which may grow, depending on elevation and exposure, junipers, oaks (including chaparral) and other deciduous trees, pines and other conifers. Many montane habitats are entirely surrounded by desert shrub and, thus, are isolated as "biological islands."

HUMAN POPULATION AND LAND USE

Indians in pre-Columbian times in northern México lived in small numbers along waterways and in well-watered mountainous areas.

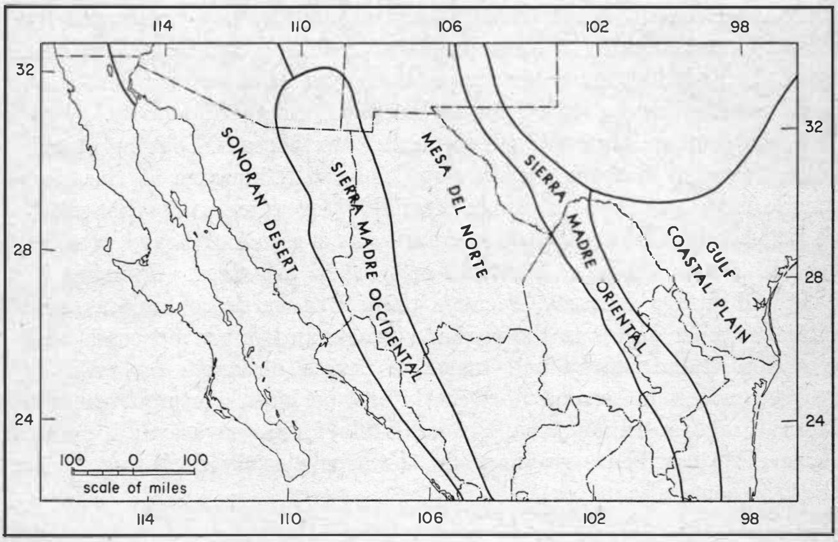

Figure 1. Major physiographic features of northern México.

The Spaniards established scattered fortified communities in many of these same places, engaged in some ranching and farming, and worked mineral deposits. These colonists were not attracted by the extreme aridity and were discouraged by the warlike nature of the Indians, a menace which was not eliminated entirely until late in the nineteenth century. Consequently, for almost 400 years following the Conquest, most of northern México remained undeveloped while the human population flourished in more humid central and southern México where dry farming could be practiced and water for livestock obtained more easily.

The Spaniards made remarkable headway in colonizing central and southern México. The sedentary Indians living there were easily managed. These people already were experienced farmers and could be trained also as herdsmen, woodcutters, and miners. Workers in all of these occupations were essential to the Spanish colonial system. However, this system was notably unsuccessful on the more arid Mesa del Norte, even though the introduced cattle and horses were adapted for life on the grasslands and the desert shrub. Figures recorded by Webb (1931: 91) show that in 1810 only about 6 per cent of the larger ranches (haciendas and estancias de ganado) and only about 9 per cent of the smaller ranches that had been established by the Spanish were on the Mesa del Norte (including adjacent parts of what is now the United States). Webb (*op. cit.*:90) further comments that in 1931 the Mesa del Norte contained only a fifth of the Mexican population even though this region comprises about half of the area of the Republic.

The recent increase in the human population and the greater utilization of the land for grazing and farming in northern México can be illustrated by census data from a typical state—Coahuila (from publications by the Secretaria de Economia, Dirección General de Estadistica, México, D.F.). From 1930 to 1950, the population in Coahuila increased about 65 per cent to 720,319 persons. This means an increase in density per square kilometer from 2.9 to 5.0 persons. The total number of livestock increased about 55 per cent: cattle up about 107 per cent (466,848 head in 1950), sheep up about 68 per cent (336,555 head in 1950) and goats up about 40 per cent (1,316,857 head in 1950). Production of the three major agricultural crops increased, in these years, about 231 per cent: wheat up about 70 per cent (54,404,614 kilograms in 1950), corn up about 63 per cent (35,085,626 kilograms in 1950), and cotton up about 305 per cent (80,597,419 kilograms in 1950).

The Coahuilan districts of Ocampo and Cuatro Ciénegas contain much of the best range in the State for bighorn, pronghorn antelope, and mule deer. Combined census figures for these two districts alone show that from 1930 to 1950 the human population increased about 39 per cent. The number of cattle increased about 44 per cent while the number of sheep and goats each decreased about 50 per cent. The production of wheat was up only 5 per cent, but corn increased about 400 per cent. The production of cotton rose from less than 1000 kilograms in 1930 to more than 72,000 kilograms in 1950.

These increases reflect, in part, the use of more efficient methods of production, but emphasize as well the increased amount of land that has been put into production. This is especially true in the case of grazing lands for cattle, and infers that competition between domestic stock and hoofed game has increased and will continue to do so as surface water supplies are increased to provide new ranges for livestock.

WILDLIFE

Prior to 1900, black bear (*Ursus americanus*), collared peccary (*Pecari tajacu*), white-tailed deer (*Odocoileus virginianus*), mule deer (*Odocoileus hemionus*), pronghorn antelope (*Antilocapra americana*), bighorn sheep (*Ovis canadensis*) and other wildlife species in northern México were little disturbed by man or by competition with his domestic livestock. It is true that bison (*Bison bison*) and wapiti or American elk (*Cervus canadensis*) had disappeared by that time, but neither species probably was ever common in this region which is located at the extreme southern edge of their former ranges (Leopold, 1947:437-438; Baker, 1956:318, 325-327). Wapiti has been re-introduced in Coahuila (Baker, *loc. cit.*). The grizzly bear (*Ursus* sp.) is still reported from Chihuahua. The gray wolf (*Canis lupus*) persists in small numbers in Chihuahua, Sonora, Durango, Zacatecas and San Luis Potosi.

Since 1900, there has been a decrease in game animals which seems correlated with the increased occupation of the land by man and his crops and livestock. Logically, game and other wildlife in the areas more accessible and attractive to man have declined first, although less so on the holdings of persons who have made an effort to manage grazing lands and to regulate hunting.

Animals of the Desert Shrub. The mule deer and collared peccary prefer the shrub cover of the desert and the foothills on the Mesa del Norte. Their ranges have been generally accessible to man, and both species have been hunted relentlessly. Mule deer is reported by Dalquest (1953:211-212) to be near extinction in San Luis Potosi.

The animal also is in serious jeopardy in Coahuila, Durango and Chihuahua. Populations of the collared peccary are scattered and sizeable bands occur only where ranchers afford this animal some protection. Likewise, white-tailed deer and wild turkey (*Meleagris gallopavo*) have largely disappeared from the northeastern lowlands owing to over-hunting and reduction of habitat, especially in the riparian growth along streams. On the other hand, waterfowl hunters and fishermen welcome the construction of the larger reservoirs, because these bodies of water attract flocks of wintering ducks and geese and provide more fishing.

Animals of the Grassland Plains. The pronghorn once occurred in México as far south as Hidalgo but now is rare and confined to scattered areas of grasslands in northern México. Like the desert, most of the Upper Sonoran grasslands are accessible to stockmen and hunters. Consequently, the pronghorn has been on a gradual decline. The status of this species in México is perhaps better known than that of any other big game animal because of the reports by Nelson (1925) and Villa-R. (1951 and 1955). Nelson estimated that there were 2,395 pronghorn in four states in northern México in 1922-24. Probably much less than half that number occur in the Republic today. For example, Nelson (1925:62) reported that in 1922-1924, there were bands of 50 to 100 pronghorn in the valley of the Encantada west of Muzquiz, Coahuila. In 1952, one animal was seen in the valley; local residents told me that any animals remaining were doomed because of the operations of "meat" hunters from nearby mining camps. If afforded the protection and opportunities given pronghorn in Texas, New Mexico and other western states in the United States, the Mexican populations of this animal could increase in many areas having suitable habitat on the Mesa del Norte. An interesting nongame species, the endemic Mexican prairie dog (*Cynomys mexicanus*), has been exterminated through poisoning and other means on much of its range (parts of Coahuila, Nuevo León, San Luis Potosi), because the animal occupies choice grazing lands and lives on or adjacent to agricultural lands (Baker, 1956:202). Furthermore, intensive programs of trapping and poisoning of the coyote (*Canis latrans*) and other meat-eaters have been in operation on many ranches.

Animals of the desert ranges and the Sierra Madres. Animals of the highlands—especially those of the desert ranges where surface water is scarce or absent—have been most secure from man's interference (grazing, hunting, lumbering, mining). However, the bighorn sheep, whose horns have lured the trophy hunter to the most remote and arid rimrock country, has declined steadily since the early years of the century. In Chihuahua and especially Coahuila the species is nearing extinction. The animal prefers arid badlands where some competition with domestic sheep and goats may occur, but the chief limiting factor seems to be persistent and unregulated hunting. Trophy hunters strive to complete their collection of bighorn heads with that of the desert subspecies of the bighorn.

The black bear prefers the oak-pine association, but is disappearing from such habitat when it becomes more accessible to hunters by road or air strip. Although this bear is recorded from as far south as central Tamaulipas, San Luis Potosi, Zacatecas and Durango, its best range seems to be the Sierra Madres and the higher, isolated desert ranges of Coahuila, Chihuahua and Sonora. Many ranchmen encourage their riders to shoot bear on sight, because each bear, in their opinions, is a potential "killer" of goats and other stock. Big game hunters, in most places, do less damage to the population of bears than do ranch hands with their saddle guns. The grizzly, although extremely rare, is still listed by hunting guides as potential game in Chihuahua.

The white-tailed deer is still common in remote mountainous districts but, as mentioned previously, has largely disappeared from the thorn shrub of the lowlands of northeastern México (eastern Coahuila, Nuevo León and Tamaulipas). The white-tail long has been a chief source of "wild" meat for workers in mining camps, fencing crews, and cattle camps. Such uses, however, are not necessarily damaging to deer herds.

The wild turkey occurs in the foothills and the pine-oak highlands. This bird has always been eagerly sought as a source of meat by residents and is especially vulnerable to hunters when it roosts in flocks in isolated trees or small groves in open country. Most of the larger populations in northern México are on ranches where some protection is afforded the birds.

Attitude of The People Toward Wildlife

Although many citizens of the Republic of México are well aware of the importance of conserving natural resources such as soil and water, few have given much thought to the values of conserving wildlife. If confronted with a deer or turkey, the reaction of many Mexicans would be to attempt to kill the animal for its meat, either to eat or sell, without being concerned whether or not the animal was the only example of that species left alive or that it happened to be protected by legal enactment. These statements are simply matters of fact and are not meant to be derogatory. This same philosophy exists today in parts of the United States and prevailed there generally as late as 1925.

Although laws have been enacted to regulate the hunting of game species in all Mexican states, I have found few rural people, the "meat" hunters, in Coahuila, Durango, and Chihuahua, who were aware of many of these regulations. Moreover, in Coahuila the fact that the entire state has been closed to all hunting since 1950 is still not generally known. This law has been a boon to conservation-minded landowners, who use this regulation as an excuse to discourage hunters from asking for permits to hunt on their lands, but it is obvious that elsewhere local enforcement of game laws has been wholly inadequate.

Trophy-hunting sportsmen, both Mexicans and Americans, are increasing. Hunting clubs with some conservation-minded members are organized in larger Mexican cities. Parties from Monterrey, México City, Guadalajara and other places go by automobile or airplane to mountain retreats in northern México to hunt bighorn, bear, deer and turkey. Likewise, guides make a lively business of escorting hunters from the United States to the Sierra Madres with the promise of fruitful hunts. Many of these hunters can afford the added expense necessary to reach remote areas within rifle range of dwindling bands of "desert" bighorn. Few of these hunters consider the need for regulating the kill or for the establishment of refuges to preserve dwindling wildlife resources.

SUMMARY

Wildlife in northern México was little disturbed by man prior to 1900. Since that time, and especially after 1920, game and other species have been steadily declining—some are in danger of extinction. Chief reasons for this decline are: (1) Reduction in adequate living space for native animals and plants. This has resulted primarily from increasingly more effective management of water resources which has allowed for a continual increase in the number of domestic livestock, in the space planted to agricultural crops and in the extent of lumbering and mining operations. (2) Unrestricted year-around hunting by both rural dwellers who use "wild" meat as part of their diet and urban residents who may hunt chiefly for sport; (3) General indifference of local people to the importance of wildlife conservation; this is in part the result of the lack of local programs in conservation education.

Suggested Actions

The following suggestions emphasizing needs for increased public conservation education seem worthy of consideration.

(1) An adequate survey of the status of big game and other endangered native species should be made. Such an investigation would reveal the present distribution, approximate numbers and need for greater protection of unique and important animals and their habitats. Remaining primitive areas, which might be potential wilderness preserves, would also be determined. Some data have already been obtained by Bernardo Villa-R. and other field investigators.

(2) It is essential that residents of northern México be made increasingly aware of the tremendous effect that the expansion of their economy has had, and will continue to have, on reducing adequate habitat for game and other wildlife. Citizens must realize also the need for supporting the enforcement of proper hunting regulations of the dwindling number of game animals present.

(3) It is equally important for a vigorous educational program to acquaint the people with the necessity of practicing sustained-yield management of all renewable resources, including wildlife, and the vital interrelationship of these resources.

(4) The economic, recreational and educational values of national or state parks have not been fully realized by residents of northern México. Although some parks and forest areas have been designated (see Galicia, in Beltrán, 1953:70-75), national and local support should foster the establishment of the Mexican part of the proposed Big Bend International Peace Park and of other parks or preserves in areas having unique or characteristic animals and plants or having scenic beauty (such as along the roadway from Durango to Mazatlán). Residents need only to observe the recreational and cultural values of the scenic and forested national parks in the vicinity of their own nation's capital to determine the present and future values of such areas in northern México.

(5) It seems appropriate to suggest also that at least one centrally-located area of large size, and including some typical desert, grassland and scenic mountain country, be set aside as a wilderness tract, where natural conditions would be preserved for all time.

Unless steps are taken to develop an informed public opinion concerning conservation of natural resources, northern México will surely lose some of its characteristic wild resources and a part of its cultural heritage and economic potential.

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DISCUSSION

CHAIRMAN WADE: We are honored at this session to have Dr. Beltrán in the audience. Unfortunately he didn't get here in time to hear the early part of this paper, but I think he picked up the last part.

If there are any remarks you would care to make, sir, we would be glad to hear from you.

DR. ENRIQUE BELTRÁN [Director, Instituto Mexicano De Recursos Renovables, Mexico, D. F.]: Well, unfortunately I was not here when Dr. Baker started his paper. I agree with most of the things he said.

Regarding the game in Mexico, the attitude is very favorable at present. You have to remember that we have been fighting for many, many years, since 1810 when we started with our war of independence until 1875. Throughout that time, there was some military movement in Mexico, and it was not very good for hunting. It was difficult to go out and hunt under those conditions.

Then, after a short time of peace there was a revolution for twenty years from 1910 to nearly 1930. And at that time it was not very safe to be in the field.

In Mexico, most of the hunting has been done by local people just to satisfy the need for meat. It is not really recreational hunting with sporting clubs and so on. There are some, but not many.

We are trying to impress people with the economic value of sports hunting to show them that in many places, in Mexico the most productive crop of the land may be wildlife well managed for sport. But, it is going to take a lot of time.

We now have a lot of sportsmen in Mexico who like to hunt, but we have so little traditional hunting at home that they make big safaris to Africa and to other places to hunt. The moment we succeed in having real sporting hunting in Mexico, I think we will have a better chance to attain real game conservation. I hope with the new roads and the social equation and the peaceful situation which has prevailed for the last thirty years—and we hope to have it for many more years—that people are now going to hunt for sport.

So I hope that some of the suggestions that Dr. Baker has made will be put into effect and into practice and maybe in a few years the situation will be much better.

In regard to the suggestions he has made about the possibility of having one of these conferences somewhere in Mexico, I would say only that we should be very, very pleased to have you there. [Applause]

CHAIRMAN WADE: Dr. Beltran, it is always a privilege for all of us to hear you. Personally, I consider you one of the great men of the North American Continent.

WHITHER CONSERVATION EDUCATION IN AMERICAN COLLEGES?

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During the last few years, interest in the conservation of natural resources has been given a new impetus by the writings of such eminent specialists as Harrison Brown, Fairfield Osborn, Paul Sears, and others; also, by the object lesson provided by the tremendous upsurge in population growth in a number of countries of the world, including our own. In our own country many informed persons are beginning to regard as serious the phenomenal rate at which our resources are being used as a result of our rapid population increase, the demand for consumer goods, and needed materials for national defense.

Since this nation has always relied heavily upon education as the chief means of enlisting support for conservation, it seems appropriate to make some inquiry concerning how well the enterprise is faring at the college level. It is known that conservation teaching is becoming fairly well established at the elementary school level, and that it has not made notable headway in the high schools. But, in spite of the fact that education in conservation had its beginnings in our colleges and universities, until recently no systematic attempt to appraise the work in these institutions had been attempted. Accordingly, at the request of the Conservation Foundation, this writer, with the assistance of a junior colleague,[1] undertook to make a preliminary study of the situation. The data were collected during the spring, summer, and fall of 1954. The manuscript was completed in August, 1955, and after editing for public consumption was published during the fall of 1957.[2]

It is not the purpose of this paper to review the study just mentioned. Rather it is the aim to present certain aspects of the findings insofar as they bear upon the general problem of conservation education in our society. The conservation movement in the United States must still be regarded as the "partisan" movement of a small minority of the population which by no means includes either all leaders of economic and social welfare, or all those who work with natural resources, or even all scientists. Those persons who have shouldered the burden of supporting and promoting the conservation movement dur-

[1]Dr. J. J. Preiss, now Assistant Professor of Sociology and Anthropology at Michigan State University.
[2]Lively, Charles E. and Jack J. Preiss. Conservation Education in the United States. New York, The Ronald Press, 1957, pp. IX + 267.

ing the sixty years or so of its existence, have, of course, hoped that their efforts would not be met by a determined opposition; that the public would at least assume a permissive attitude so that conservation effort would not be impeded by positive public interference. Instead, the crusaders for conservation have met not only indifference, but both passive and active resistance. The general public has not yet become sufficiently involved in the movement to make an intelligent approach to the problems of resource exploitation and use.

The social scientist is almost certain to regard the effort by which any group of people conserves its resources as a social process that ultimately must involve the entire group. Unless a controlling element in the group (and in a democracy that means a majority) can become actively involved in the conservation process, the task cannot be wholly accomplished. Conservation is really a way of life, a way of looking at resources, and a way of behaving toward them. While the task may appear to be simple when a single individual stands regarding his dwindling supply of resources, it becomes a complex task involving many technologies when a society composed of millions of people undertakes to live the conservation way. At least seven tasks are then involved. They may be stated as follows:

1. Maintain a thorough knowledge of the supply of natural resources available, insofar as the current level of technology will permit.
2. Husband carefully those essential resources in short supply and, following their use, effect recovery of as much of them as may be physically and/or economically possible.
3. Exert sufficient effort to replace renewable resources at a rate equal to consumption.
4. Estimate continuously the rate of growth of the population and changes in its composition, and thus anticipate its needs in terms of resources.
5. Develop scientific technology at a rate that will enable the level of consumable supplies fabricated from the utilization of previously known resources, and from newly discovered or invented resources, to be maintained at an optimum.
6. Educate the people to understand the necessity of keeping a balance between consumption and availability of supplies so that when and where necessary they may voluntarily adjust the factors affecting demand, including population increase, to the outlook for consumption.
7. Recognize clearly that nature may not with safety be recklessly despoiled: that by disrupting the complicated ecological relation-

ships existing in nature, before he has the knowledge to compensate permanently for such change, man may be making a serious blunder.

This list of the tasks[3] of conservation may be regarded as the statement of an ideal against which the conservation achievements of any society may be measured at any time. Although certain of these tasks may be performed properly only by experts, it is clear that, in a democracy, most of the tasks are basically educational in nature. For although specialists must play an extremely important role in carrying on the conservation process, a well educated public is essential not only for lending support to the efforts of the specialists, but for intelligently regulating its own behavior in the presence of such resources as need to be conserved. Such behavior assumes that the general public is in possession of favorable knowledge, habits, and attitudes. This fact has been recognized by many states; and knowing that many of the basic attitudes and habits related to good citizenship must be formed early in life, they have required conservation to be taught in the elementary schools. Also they have required their teachers' colleges to prepare teachers for the task, and many of them have worked at it with vigor.

But if conservation is to be a way of life, then the individual must both grow into it, and grow up to it. The elementary school child may very well grasp some of the significance of conservation through nature study, and the planting of trees on Arbor Day; and he may thus form some attitudes and habits that are essential to conservation behavior. But he will scarcely grasp the full social significance of the seven tasks outlined above until he has reached a level of maturity equivalent to that of a college education. This is why good education in conservation is so essential in our colleges and universities. As the child develops, interests may change and skills may be lost, but a mature social philosophy obtained at the college level may endure throughout life.

With this sketchy background, let us look briefly at the present status of conservation teaching in the colleges and universities of the United States.

In terms of teaching or not teaching, only six of the 92 land grant and other large universities investigated (*i.e.,* those having 7000 or more students enrolled) offered no courses in conservation of natural resources. This was anticipated since it was among these large institutions, many of them publicly supported, that the pioneer work in

[3]Viewed from the standpoint of these tasks, conservation in a dynamic society may be defined as follows: Conservation consists of equating the use of natural resources and the varying demands of population to the extent that existing resource supplies will not become exhausted before adequate substitute supplies have been discovered or invented and made available for use. Cf. Lively and Preiss, *Conservation Education in American Colleges*, p. 15.

conservation education was developed. Some of them are distinct leaders in this field today. The most important criticism that can be leveled against these institutions is that, relative to the size of their student bodies, the student coverage is small. The conservation courses are likely to be occupationally oriented, and liberal arts students are unlikely to enroll in even one conservation course. By contrast, it was found that only 55 per cent of the 1024 colleges[4] and universities enrolling fewer than 7000 students offered one or more courses in conservation. The teachers' colleges averaged much higher (89 per cent) and the special schools much lower (30 per cent). The numerous colleges of arts and sciences, liberal arts, and small universities, and the junior colleges, were very close to the general average of 55 per cent.

It is noteworthy that the incidence of conservation teaching in these colleges and universities varies in accordance with a number of factors, some of which are environmental and some inherent in the nature of the institutions. In the aggregate, conservation is most likely to be taught in colleges and universities located in the Mountain and Pacific states, and least likely to be taught in those located in the Northeastern and Southeastern states. Other factors related to the probability of teaching, or not teaching conservation, are the size of the place where the school is located, the sources of financial support, the size of student enrollment, the nature of the curriculum, and whether the school is operated for one sex or both. On the basis of these variables, the schools most likely to be teaching conservation are western schools; schools located in places of less than 50,000 population; schools with no religious affiliation, but supported by public funds; schools with 2500 or more students enrolled; schools that are co-educational; and schools with education as the major curriculum.

Some of the contrasts based upon these variable factors are very significant. For examples, 62 per cent of the colleges and universities located in places of less than 50,000 population were teaching conservation, but only 32 per cent of those located in places of 750,000 population or more were so doing. Three in five of the co-educational schools were teaching some conservation, but only two in five of the female colleges, and one in five of the colleges for males only were doing likewise. More than three-fourths (77 per cent) of the schools teaching no conservation were privately supported institutions, and only one-fifth (21 per cent) were publicly supported. One reason for this sharp contrast between public and private schools is that the latter are much more likely to be small schools, with enrollments of

[4]Included in the sample studied.

only a few hundred students. At present, small colleges are less likely to be teaching conservation than large ones.

A special questionnaire was submitted to the teachers of conservation to learn something of their philosophy, their teaching load in terms of conservation courses, student enrollment in these courses, and the aspects of conservation presented. On a proportional basis, all teaching fields were reasonably well represented except physical science. However, it seems likely that those conservation teachers with a strong interest in the subject were better represented in the returns than those with a low interest.

The outlook of these teachers concerning the future of our economy varied greatly. Half of them expressed definite optimism regarding the future, and one in three thought the economy could expand indefinitely. One in five thought the American people are either moderately economical, or most economical. One in 10 saw no resource crises ahead. Half of them believed shortages would appear, but that adequate substitutes would be found. Less than one in five tended to be pessimistic regarding the future of our resources.

In explaining the public attitude toward conservation, three teachers in five thought ignorance of resource use is largely the cause of present indifference and low popularity. However, 46 per cent blamed past American habits of resource destruction, and attitudes of irresponsibility. An equal number felt that current pressures to consume, and the belief that science will save us, are also important factors. Nearly one-fourth believed we shall practice conservation when necessary.

In order to make conservation effective, these teachers believed that merely presenting the facts as to resource use and outlook is not sufficient. Seven out of 10 said conservation must be made a part of the personal beliefs and habits of the people if the teaching is to be effective in terms of social action. Only 28 per cent thought that making conservation effective with all persons working directly with natural resources would be adequate for society; and only one in four thought that conservation could be achieved by means of law alone. A majority believed that conservation should be taught to all college students.

A point of considerable interest is that the social science field provided the fewest courses in conservation, and only 9 per cent of the replies to the teacher questionnaire. Yet, when all teacher-respondents ranked the various subject matter fields in the order of their assumed value in teaching conservation, social science was placed second, ranking next to natural science. Nine teachers out of 10 believed social scientists have a contribution to make in the field of conservation.

However, social scientists, economists excepted, have been slow to recognize conservation as a promising field for their endeavor. Economists, social historians and sociologists with an interest in population might well make important contributions to this field.

The questionnaire called for a definition of conservation; and considering the fact that the respondents were teachers of the subject one might expect some good definitions. Instead they were disappointing. Fewer than one in five (18 per cent) offered "avoidance of waste and replenishment," and one in 10 mentioned "economic efficiency." All other definitions were offered by less than 10 per cent of the respondents, with one exception, namely, "wise use." A total of 43 per cent gave this definition. It varied from 37 per cent in the 4-year college and small university group to 63 per cent in the teachers' college group.

It is exceedingly unfortunate that such a large proportion of our college teachers of conservation are relying upon such an inadequate definition of conservation and passing it on to their students. Such a definition provides no criteria for conservation behavior at any given time or place. Who is to determine under any specific circumstances what "wise use" is to be? Is "wise use" agreed upon today likely to be considered wise use tomorrow? Clearly, unless we can provide a definition of conservation in terms of societal tasks to be performed (such as the seven tasks listed earlier in this paper), we will not have progressed beyond the elementary notion of frugality and hoarding. Surely, some further teacher education in this regard is highly desirable.

Another way of visualizing the variable situation among the colleges is to contrast the best teaching programs with the poorest. Recall to mind that 41.5 per cent of all institutions studied offered no work in conservation education. Also 44.7 per cent of all schools, exclusive of the land-grant group of colleges and universities, and those universities with student enrollments of 7000 or more provided no conservation education.: This leaves 55.3 per cent of the small universities and colleges offering some conservation. Of these, the 73 institutions regarded as having the best developed programs of conservation education may be described typologically as follows: 86 per cent were co-educational, and 82 per cent had no religious affiliation. Although they varied greatly in enrollment, only 15 per cent had fewer than 500 students. None had fewer than two teachers of conservation, and two out of three had five or more such teachers. Education in conservation was offered in both special courses and integrated courses. The aspects of conservation taught were likely to be seven or more. Three in five of these schools offered courses dealing with the conservation of minerals, soils, water, wildlife, forests, ecology, and recreation. Nearly half offered range management, and a few offered oceanography. These offerings ranged through six departments, or subject matter areas. Two in five of the administrators of these institutions believed the work offered in conservation was adequate; but the teachers were a bit less certain. Nearly half of the schools reported some plans for improving their teaching programs in conservation, and were generally favorable toward obtaining some assistance in putting their plans into effect.

By contrast, the 119 colleges and small universities regarded as having the poorest developed programs in conservation education possessed the following characteristics: Nearly three in 5 (57 per cent) were of the arts and science type of institution. More than half (55 per cent) enrolled fewer than 500 students, and 76 per cent fewer than 900 students. Only one in 30 had as many as 4000 students. More than four out of five (85 per cent) were co-educational. Nearly seven out of 10 (68 per cent) were privately supported, and half of them were church related. They reported one to three persons teaching some conservation. Nine out of ten had no more than three and one-third had but one teacher. The conservation topics offered dealt mostly with soils, water, forests, and minerals, taught in the areas of natural science and physical science. In two-thirds of these schools, the administrators judged their programs to be inadequate. However, eight per cent thought them to be entirely adequate. Seven out of 10 had no plans for expanding their conservation offerings. Only 23 per cent reported such plans, though among the junior colleges the proportion was 37 per cent. Two out of three said some outside help would be needed if expansion were to occur.

This brief picture of the teaching of conservation in the colleges and universities is sketchy and impressionistic, and scarcely does justice to the mass of information upon which this paper is based. It does make clear, however, that in the colleges and universities of the United States, the subject of conservation of natural resources is by no means generally taught; and in most of those institutions where it is offered, student exposure to one or more courses is definitely limited. Furthermore, in the schools where some conservation is taught, the courses are very unequally distributed. Of the 961 courses reported by conservation teachers, 83 cent were being taught in institutions with no religious affiliation. A disproportionately large number were offered by the land-grant and other large universities.

Teacher evaluation of their institutional programs in conservation were more critical than that of their administrators, and the smaller institutions tended to offer the more critical evaluations. However, the opinion of administrators was by no means uniform concerning the place of conservation in the college curriculum. Some even expressed the view that the subject has no legitimate place in the curriculum of a liberal arts college. Thus the belief that education in conservation belongs not only in technical curricula, but in general education as well, appears not to be generally accepted by college administrators.

In view of the findings, it seems that an action program to aid and encourage non-teaching institutions to include courses in conservation in their curricula might achieve some success. On the average, these institutions are smaller, privately supported, and located in the larger population centers. Many of the administrators in these colleges admitted their inadequacy, and expressed a need for trained teachers, visual aids, and administrative assistance in improving their conservation teaching programs. More adequately trained teachers are needed, and some special effort to make conservation education a part of general education is needed. So long as conservation continues to be regarded as an occupational specialty to be taught only in technical course sequences, the general college-going public will remain ignorant of this highly important preparation for citizenship in a democracy.

DISCUSSION

DR. E. LAURENCE PALMER: I am not going to say much about the particular paper except I stayed through the morning, hoping I would hear something on a point which is very close to me. I don't know of too many institutions that are deliberately going out to prepare teachers who will teach at the college level. Unless we can have adequately-trained people to work at that level, I don't see where we can get anywhere.

At Cornell, where I taught for 35 or more years, we had support from the American Nature Association in the form of $2,000 a year grant and through that placed around 50 Ph.D. candidates in teacher training institutions from coast to coast. At present, there is no such support. Instead, we have $50,000 from other sources to help students and one six-week summer school course, but we have no support for workers at the higher prolonged sustained training level. I think that is a severe weakness that exists at present. I wish it might be corrected.

MR. BERNIE LAPPIN [Principia College, Fort Smith, Arkansas]: Could you give me, sir, with your consideration, an adequate definition for conservation?

DR. LIVELY: I can give you a capsule definition. Viewed from the standpoint of the seven tasks, conservation in a dynamic society may be defined as equating the use of natural resources and the varying demands of population to the extent that existing resource supplies will not become exhausted before adequate substitute supplies have been discovered, invented, and made available for use.

MR. H. RAYMOND GREGG [National Park Service, Omaha, Nebraska]: Your last statement raised a question in my mind, what will be the substitute for wilderness?

DR. LIVELY: I don't know the answer to that. I think it depends primarily on the vicissitudes of the public and whether they come to incorporate wilderness as a substantial, lasting value in this society. It is just like religion. Some people don't believe in religion. They say they don't. Of course, they have some kind of a religion they go by.

But, I take it that a thing such as wilderness represents a social value. Some people will want it very much and others will not want it. We have between here and Columbia an area which the Missouri Society has purchased. It is virgin prairie. It has never been plowed. A lot of people around here think that it is nonsense, I am sure, but many of us feel there is a value there that we would fight for. But unless we can incorporate things like that in our basic social values, then we just won't have wilderness.

Dr. Walter Taylor: I don't think it is necessary to put the emphasis on wilderness. What is going to be the substitute for space?

Mr. William L. Jellison [U. S. P. H. S. Hamilton, Montana]: I think we can preserve it as we have the western cowboy—on the movie screen. And I think the substitute is terrible.

Mr. Clyde Gladfelter [Kansas State Teachers College, Emporia, Kansas]: Were the conservation courses, two-hour, three-hour or four-hour courses in most of the colleges? And secondly, what is a good textbook for a college conservation class?

Dr. Lively: I can't answer the first question offhand, but the courses varied from two to five hours because some of them were not straight conservation courses, such as you find in geography departments, for instance. Many of them were courses in which conservation represented 20 per cent of the time. We have that tabulated as to the proportion of time for all the nine hundred and some courses that were devoted to conservation. But I can't give it to you offhand here.

As to a textbook, I am not a technician in the field of conservation. I am inclined to think that for the elementary and high school, let us say, where there hasn't been very much done apparently in the matter of teaching conservation, I am inclined to think that there are adequate textbooks because they would still be emphasizing skills and information. But, at the college level, I question whether there is a good one yet.

One of the reasons is that the social sciences have not entered the field, and with all due respect to my friends in the physical and biological sciences, they understand the need, but they don't feel adequate to write it. In order to get a mature, social philosophy of this matter at the college level, we are going to have to have some social sciences, economics and sociology, history and political science in that best textbook, and if so, it hasn't been written yet.

Discussion Leader Capps: Are there other questions? I don't believe Dr. Lively will object if I just close this discussion with a section that he left out of his paper that, I think, is a good summary of the situation as it looks to me today.

"The conservation movement in the United States must still be regarded as the partisan movement of a small minority of the population which, by no means, includes either all leaders of economic and social welfare or all those who work with natural resources, or even all scientists. Those persons who have shouldered the burden of supporting and promoting the conservation movement during the sixty years or so of its existence have, of course, hoped that their efforts would not be met by a determined opposition; that the public would at least assume a permissive attitude so that conservation effort would not be impeded by positive public interference.

"Instead, the crusaders for conservation have met not only indifference, but both passive and active resistance. The general public has not yet become sufficiently involved in the movement to make an intelligent approach to the problem of resource exploitation and use."

CONSERVATION IN AN EXPANDING ECONOMY: AN APPRAISAL OF THE 23RD NORTH AMERICAN WILDLIFE CONFERENCE

E. R. KALMBACH

Former Director, Wildlife Research Laboratory, Denver, Colorado

To disentangle myself from my present predicament, let me confide to you a formula with which to appraise the merits of programs dealing largely with technical subjects. It is the product of many hours of patient (sometimes nodding) attendance at meetings. In fact, had I ever attained distinction in the realm of program evaluation, my formula might even be called a "law," "Kalmbach's Law of Program Appraisal."

The mathematics of it is simple. There are only three parts or categories under which one may classify such papers.

The first of these includes those in which the subject matter is worthwhile and the presentation is adequate and appropriate. They are the papers that crowd the assembly room.

The second group includes papers with significant subject matter but their presentation leaves much to be desired. These are the ones that should be read, not heard.

The third group is characterized by papers that were in need of additional care in preparation, a fact invariably leading to ineffective presentation. These are the ones that fill the corridors.

That, in brief, is the "Kalmbach Law." This is the first time it has been announced publicly, and it may have created some uneasiness among member of the audience who had appeared on programs of this conference.

But let me hasten to put all of you at ease. My sole purpose in promulgating the Kalmbach Law of program appraisal is to give you an opportunity to judge and classify (not the contributions to this conference) but, rather, the one to which you are now listening. You may place my remarks in category one, two or three. And, I may add, there is still another group of papers that lie wholly beyond the purview of the Kalmbach Law, and to which you may wish to relegate my comments. They are the ones which never should have been thought of in the first place.

Sensing my own limitations in this tough job, I decided to approach it in a manner different from that followed by my predecessors. I propose to reveal the tenor and substance of this conference in the light of the 29 wildlife conferences that preceded it. Comparisons will be made, contrasts pointed out, and the trends of our thinking revealed, with some possibility of predicting things to come.

But first a few remarks to remind you of the course of events that eventually led to this conference.

In 1911 there was formed (under its corporate designation) "The American Game Protective and Propagation Association," later abbreviated to "The American Game Association." Under its auspices annual conferences were held, first under the name of "National Conference on American Game Breeding and Preserving." Later, these gatherings became known as "National Game Conferences," and, finally, "American Game Conferences."

In the earlier years, part or all of the important papers appeared in the *Bulletin* of that organization, later published as *American Game*. It was not until 1928 (which marked the 15th year of these early conferences) that the transactions thereof appeared as a paper-bound volume. Such publication was continued until Volume 21 in 1935. In 1936 President Franklin D. Roosevelt issued a call for the first of the current series of North American Wildlife Conferences, the transactions of which appeared as Volume 1 of the current series, and were printed as a public document of the 74th Congress. Thereafter, and continuing down to the present time, the conferences have been held and the *Transactions* published under the auspices of the Wildlife Management Institute.

Now, after 29 years, 1777 contributed papers, more than 15,000 pages of printed matter, and possibly 2 million or more words, we arrive at this, the 23d North American Wildlife Conference. And, in quoting these figures, I did not include the numerous welcoming addresses of our hosts nor those ever-gracious remarks of "Pink" Gutermuth, drawing the conferences to a close, thanking us for our attendance, and for having let him do most of the work.

At the very real risk of losing some of my audience, I have ventured to present ideas through the use of graphs shown on the screen. This was impelled by the fact that I lack the radiant oratory of a Justin Leonard or a Mel Steen, but it has justification in the Oriental maxim that "one picture is worth 10,000 words."

Accordingly, let us look for a moment at what we have been discussing for these many years (Figure 1).

In the first place the categories selected appear to be those most accurately descriptive of the papers segregated thereunder. Other topical headings might have been chosen and those used might have been subdivided, but this would have added complications without clarifying the picture. In making the allocations your summarizer simply had to use his judgment, which may not have been the best in all cases. Others, doubtless, would have come up with other decisions, and I am not certain that, were I to do it over, I would come up with the same answers. So, with these uncertainties, please bear with me for what it is worth.

You will note that, clockwise, the categories have been arranged in their decreasing proportions. The combined topics of fisheries and waterfowl have comprised about a fourth of all our deliberations.

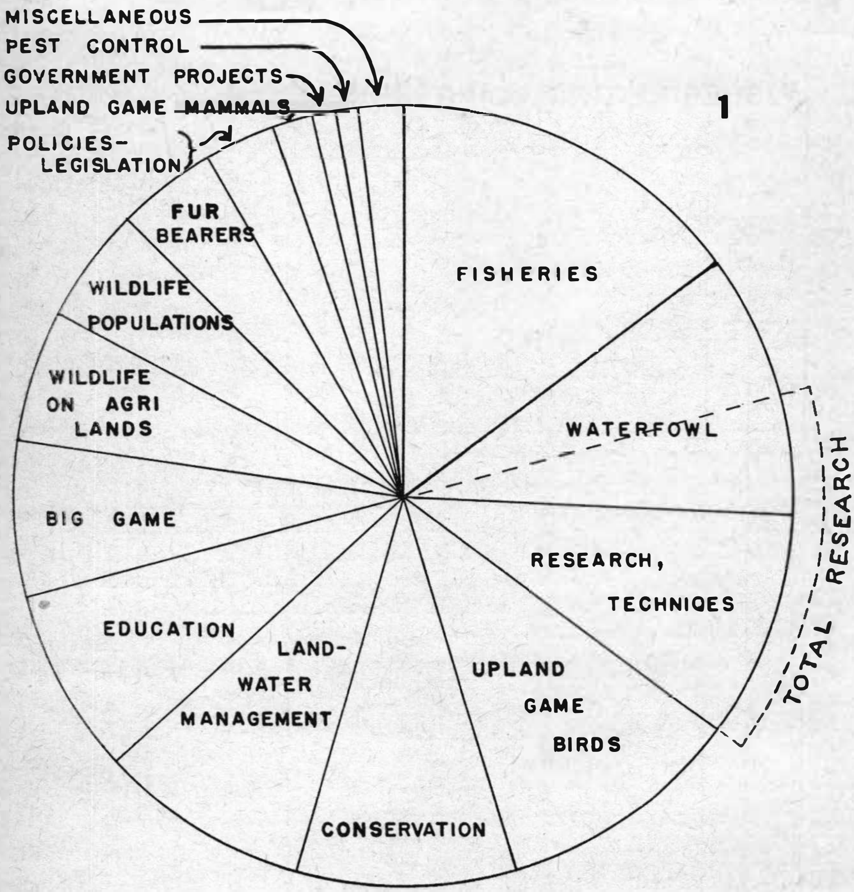

Figure 1 represents the segregation, topically, of 1777 papers presented at Wildlife Conferences from 1928 to 1957, inclusive. Figures 2 to 13, inclusive, show (percentage-wise) the emphasis placed on the respective topic in each of the years. Discussion of the trends in each topic is presented at appropriate points in the text.

Under each of these two categories, as well as in the case of other topics, there were papers that dealt with the research aspects of the problem. Had these papers been segregated and added to those which dealt primarily with research and techniques, such a grouping would have been the dominant one in the chart, as indicated by the accessory segment outlined by the broken line. To one who has spent much of his mature life in that field, this speaks well for the soundness of these wildlife conferences, particularly when we find research buttressed by substantial contributions in the realm of education.

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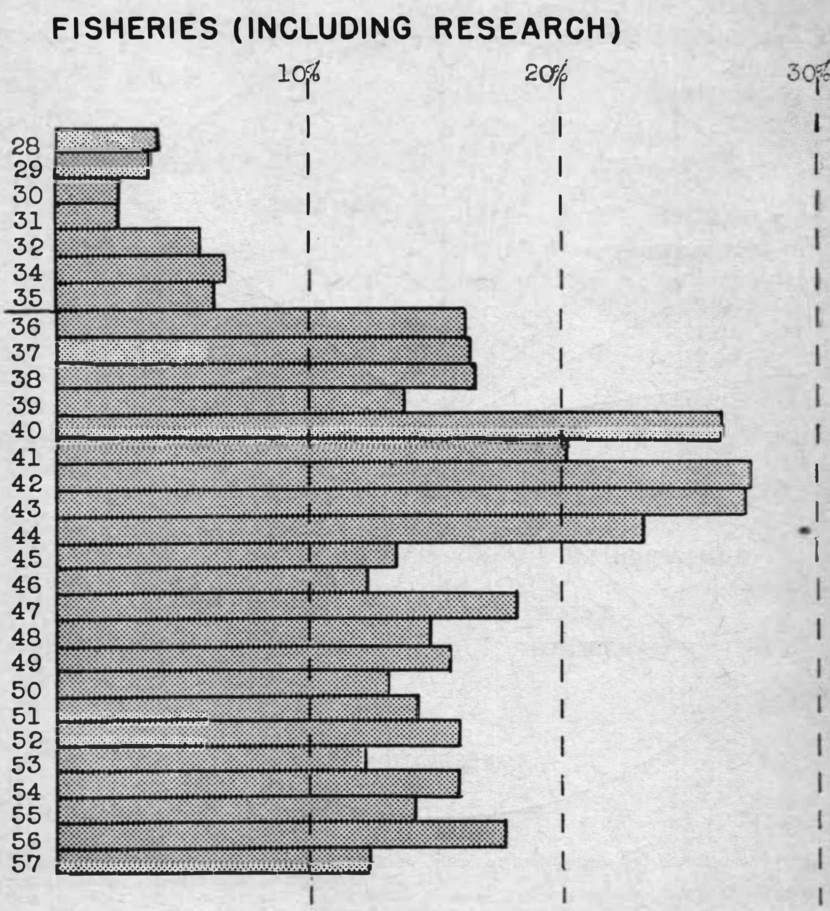

Let us now take a look at the trends of our thinking through the years. The first of these charts deals with contributions under the heading of "fisheries" (Figure 2). A few words of explanation will apply to this and the following graphs.

Here, in a perpendicular column, are represented (percentage-wise) the proportion of fishery papers presented at each of the conferences from 1928 to 1957. It was necessary to present the information on a percentage basis for each conference, since the total number of papers varied from year to year, from a high of 118 in 1936 to a low of 26 in 1928. The broken vertical lines, with percentages indicated at the top, will help you visualize the emphasis place on these topics through the years. Also, let me repeat an earlier remark, that, from 1928 through 1935, the conferences were under the sponsorship of the American Game Association, while those subsequent to 1936 were sponsored by the Wildlife Management Institute. In this and the following graphs, this point is indicated by a heavy line in the date column. It also denotes a change of emphasis from the propagation of game to improvement of habitat as a fundamental in management.

Bear in mind that, in this and following graphs, a number of different aspects of the major topic are involved. In this one dealing with fisheries there were papers concerned with fish culture, management, population measurement, stocking, utilization and, as indicated in the heading, fishery research.

The increased interest in fishery matters was coincident with the change of emphasis just alluded to. There also is a definite reason for the increased interest from 1940 to 1944, inclusive, when the war effort focused attention on management of fishery resources.

Since I have had little background in fishery matters, it would be presumptuous for me to comment on the trends in the science or industry. I am aware, however, of some criticism levelled at research in this field because of the prevalence of short-term projects of an applied nature, apparently at the expense of fundamental studies. Whereas I admit such criticisms have been valid in the branches of the natural sciences with which I am acquainted, I am not ready to frown on *all* such projects merely because the application of their results might have been seen or were expected just around the corner. If foresight, or good fortune, has led our research to the doorstep of application, so much the better, especially when, in the course thereof, facts of a fundamental nature may have been demonstrated or show up as biproducts.

As I see it, the bane of resource research, particularly in state or federal channels, lies in the time schedule so frequently imposed.

Answers which are dependent on appreciable time, are expected next week. When these are not forthcoming, operations often proceed regardless, often with an attitude of research be damned. Nothing demonstrates this better than the rapidly expanding application of highly toxic insecticides, herbicides and rodenticides, by airplane dispersal at the present time. Dire results on fishes already have been demonstrated at many points.

Now, as for the fishery papers in this conference. Bear in mind, that, if I mention a particular paper to stress a point, it should not be inferred that others may not be of equal importance or merit. Please do not be offended if I have not mentioned your paper. To present this summary as planned only a few papers can be cited; time simply will not permit commenting on all.

The paper by Tabb on the estuarine zoology of Florida waters brings

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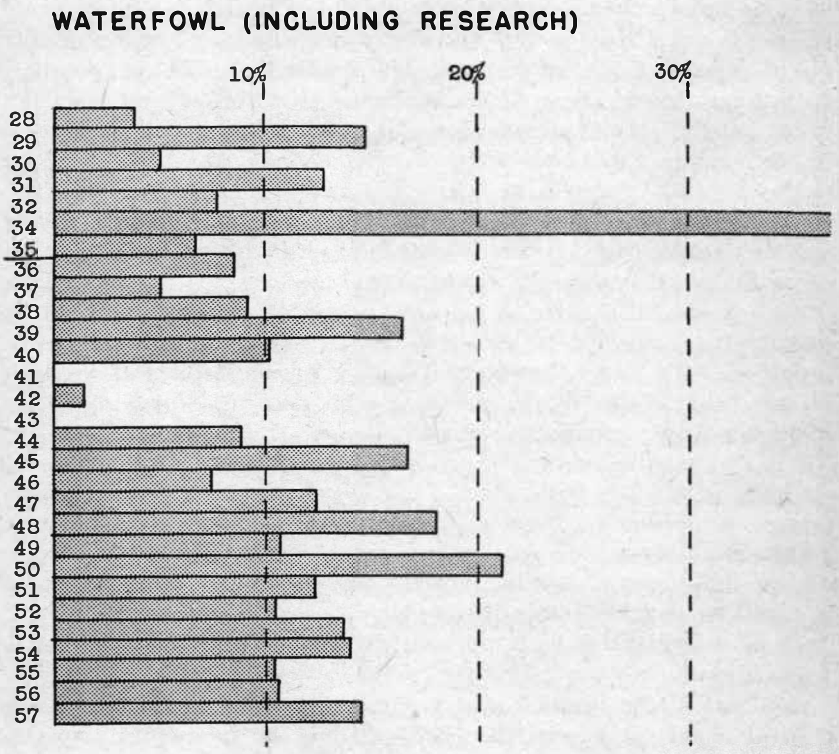


home pointedly the effects of human activities in this rapidly changing State. Continued and increasing alteration of habitat will result in the destruction of local populations of weakfish. At the same time sport anglers are taking a greater proportion of the weakfish harvest.

Though presented primarily from a fishery viewpoint, Pelgren's paper on California's water-development program emphasizes the multiple-use concept in which the values associated with recreation, fish and wildlife are recognized along with those things frequently considered to be of greater economic concern.

Two features characterize the graph depicting the contributions to the literature on waterfowl (Figure 3), the emphasis in 1934 and the lack thereof from 1941 to 1943. The first of these reflects the increasing concern regarding the possible fate of North American waterfowl because of the prolonged drouth which had reached a climax at that time. Fourteen of the 22 papers dealing with waterfowl in the 1934 conference were devoted to appraisal of the reduced populations.

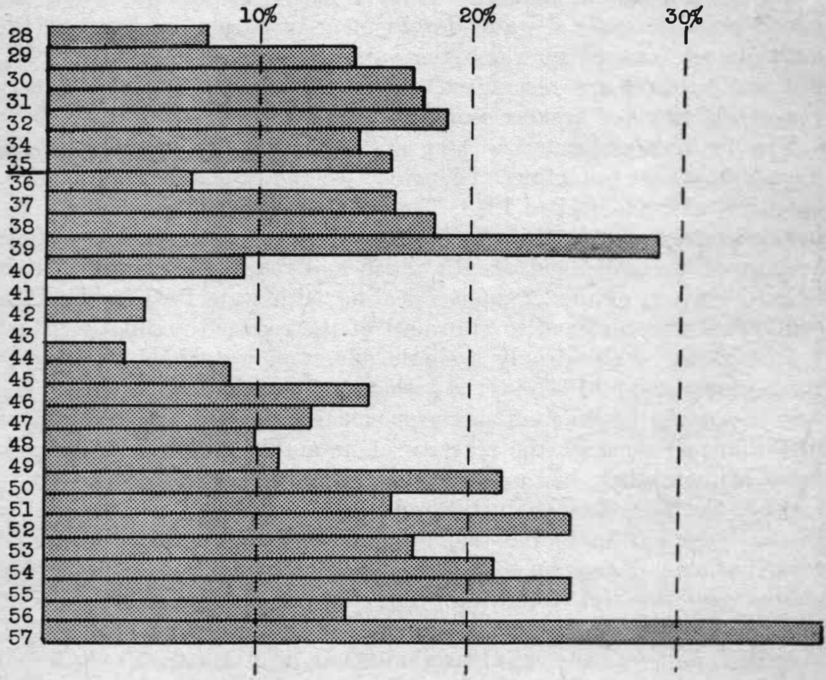
In contrast, we find only a single paper on waterfowl during the three-year period (1941-43) and that dealt with field studies. The war effort, the presence of many sportsmen and wildlife technicians in the armed services, the scarcity of ammunition for hunting purposes, all, doubtless, had a bearing on this.

Since the war, interest in the welfare of waterfowl as reflected by these papers, has fluctuated, averaging above 10 per cent of the annual contributions. Management has been a dominant theme, with field studies and research following. The present conference has added several significant papers to the literature on waterfowl. The Elder-Woodside paper on the rare Hawaiian goose disclosed the newly-found location of the residual breeding population on the lava fields of Mauna Loa where facts important to the managed survival of the species were determined. These, coupled with the program of rearing in captivity, being conducted by the Hawaiian Board of Forestry and Agriculture, give promise of perpetuating and increasing the numbers of this goose, native only to the Hawaiian Islands.

Milonski has extended the area of research about the Delta (Manitoba) Waterfowl Research Station to include farmlands 10 or more miles from marsh habitat. In addition, farms as far as 25 miles south of the marsh were studied. On more than 15,000 acres of farm land and adjacent roadsides, 524 duck nests (mainly of pintails) were found, an average density of 1 to 30 acres. Since this compares favorably with the density of 1 nest per 26 acres found by Sowls on the Delta marsh itself, we are forced to broaden our horizon somewhat on what constitutes duck-producing habitat in that region.

4

TOTAL RESEARCH AND TECHNIQUES



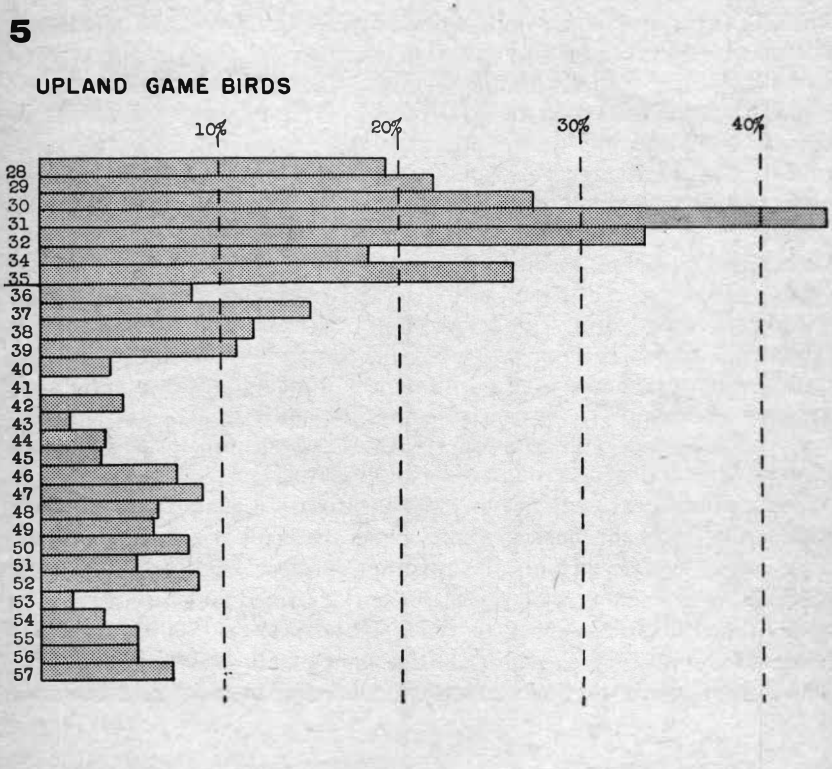
The next chart (Figure 4), depicting total research and techniques, presents an interesting story. In compiling it I have segregated those papers dealing with research in a variety of fields. Some of these have also been included in the charts devoted to fisheries, waterfowl and other groupings when the dominant consideration was not research. Papers dealing with disease, nutrition, anatomy, reproduction, cycles, food habits, and similar approaches are included here.

You will note that research and techniques were involved in a substantial part of the conferences sponsored by the American Game Association. With the coming of the first North American Wildlife Conference there is a drop due to the emphasis on conservation at that time. In the years following, research increased apace until 1939, when such papers comprised nearly 30 per cent of those submitted. There is a reason for this. You may recall that the Pittman-Robertson

Act was enacted by the Congress in 1937 and the initial allotment of $1,000,000 was provided in 1938. So, in 1939 we see the results appearing in the substantial increase in the number of papers presented at the Wildlife Conference. Most of these were prepared by young technicians who were not fully aware of what was soon to be their fate. The war came, and with it the drafting of these young men into the military service. The result—a marked reduction in the number of papers dealing with wildlife research during the war years.

Thereafter, we see a fluctuating, but general increase in research, reaching an all-time high (percentage-wise) last year, when more than 36 per cent of the papers were so classified.

In the present conference, Jellison and co-authors have discussed the irruption of *Microtus* in northern California, Nevada and southern Oregon. In common with other irruptions of small rodents, this one is now running its course and appears to be on the wane. Likewise, in common with many other irruptions, there is evidence of disease playing a part in terminating the outbreak. Tularemia, in epizootic proportions, was observed at one point in the Poe Valley in Klamath



County, Oregon and a streptococcal infection was found commonly at other points.

During the period 1928-1935 the propagation of game, particularly that of upland game birds, was a primary concern of the American Game Association (Figure 5). More than 60 per cent of the papers recorded on this graph above the line marking the change in sponsorship, dealt with various aspects of propagation. Since then, propagation, while still a tool in certain spheres of upland game management, has relinquished much to the concept of habitat improvement. The dip during the war was the result of the same causes mentioned with previously shown graphs.

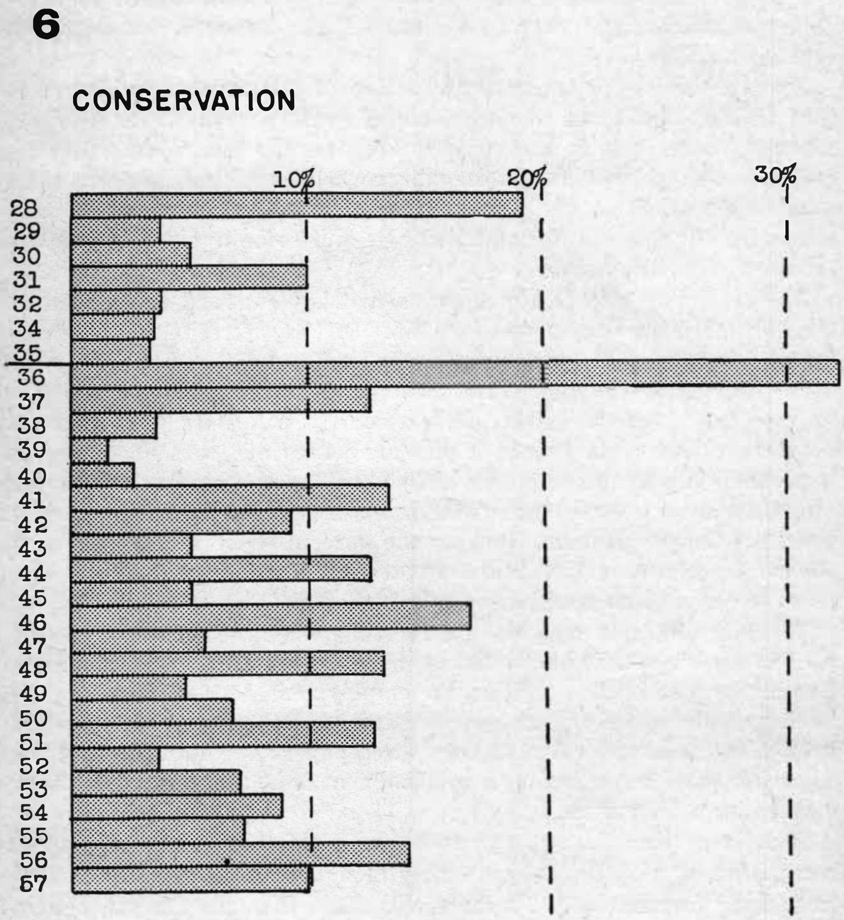
The present conference provided seven contributions on the management and research connected with upland game birds. Dale and DeWitt have added evidence to Dale's earlier conviction that pheasant welfare and survival may depend on factors other than minimum or maximum temperatures, snowfall and suitable cover. The unseen element of calcium may play an even more important role than previously supposed, and now DeWitt finds that calcium and phosphorus requirements are related to the protein level of the diet and that the protein level, in turn, may be an important factor in the success of pheasants. All of which makes us sit back and take another look at the criteria usually set up for the expected survival of introduced exotics.

Christensen in Nevada and Gallizioli in Arizona reported studies on the effect of hunting on upland game species, the chukar partridge and Gambel quail, respectively. In each case population fluctuations over a period of years were approximately the same on hunted and control areas where there was no hunting. Climatic conditions and their effect on the range strongly affected the status of the chukar partridge. Wallmo and Uzzell came up with similar conclusions with respect to scaled and Gambel's quail in Texas, and they add that "hunting intensity apparently adjusts slowly to the availability of quail because previous success influences hunting interest more than existing conditions." To the reviewer it would seem that these fellows in Texas don't tell each other where the best hunting may be had: each one has to learn through his own efforts.

Some unnatural segregation was required to classify the papers under the topic of conservation which ranged from international agreements to a discussion of vanishing species (Figure 6). Because of their heterogeneity, the papers, when arranged in graph form, reveal fluctuations from year to year. In only one (1936) do we find conservation oratory exceeding 30 per cent of all contributions. That was the first conference of the current series when those in attendance were profusely annointed with the gospel in all its aspects. Then as if the Magian wisdom had vanished, we see, in the years following, a pronounced recession.

One paper in this morning's session on education dealt more with the philosophy of conservation. I refer to Dr. Happ's paper, "Resource Management and Human Ecology." He pointed out that man, since the Stone Age, has been in ecological contact with his environment and frequently has been a determining factor in this relationship. Man's decisions, intelligent or ignorant, in this respect have been reflected in his welfare and status of his resources.

As we scan the human census figures of this country and elsewhere,



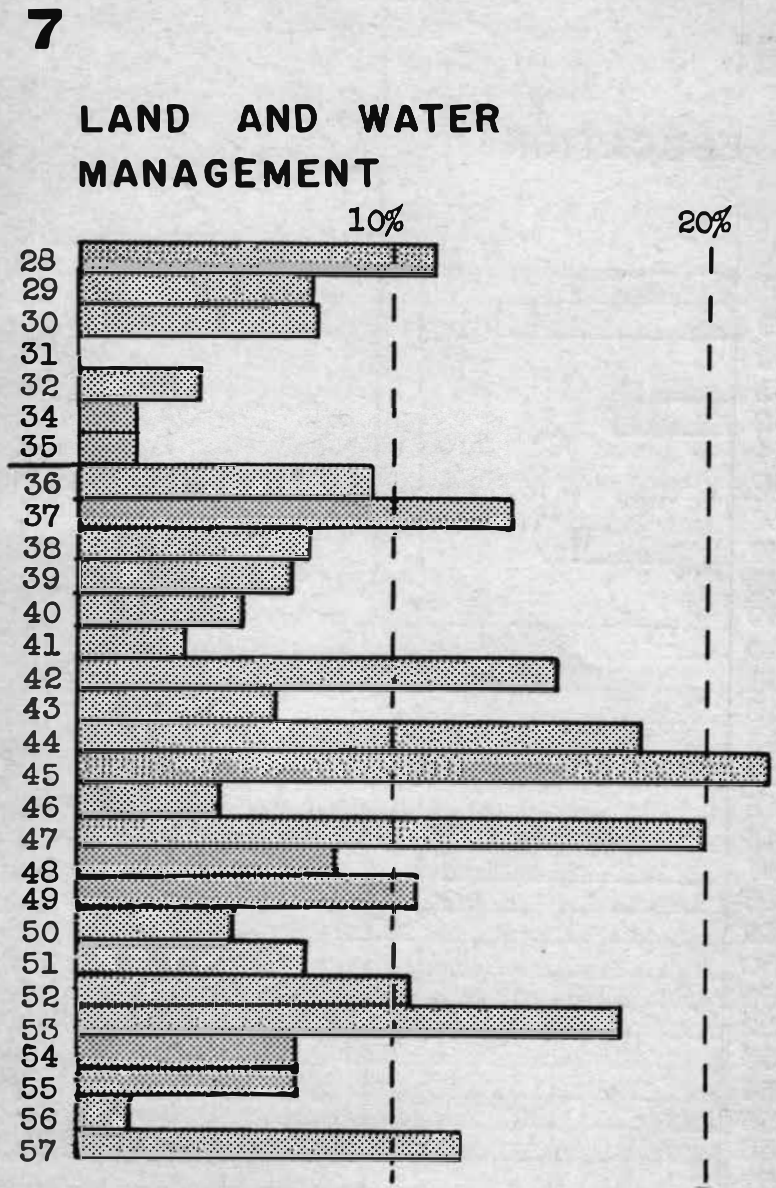
it is questionable whether, with all our advancements in conservation technique and education, we have kept pace with those geometrically mounting figures. I believe it can be stated, truthfully, that most of the papers offered at these conferences, have at least by implication, recognized the human being as an entity in the world's ecological complex. Usually this has been considered an inevitable situation to be met or endured as best we can and somewhat foreign to the province of these conferences. In only three of the 1,777 papers presented during the 29 years encompassed in this review, has the author stated that something might have to be done about it. The first of these was that of Dr. Kingsley Davis who, at the 1953 conference, discussed "Future Population Trends and Their Significance." He approached the subject primarily from the viewpoint of the demographer, not the ecologist.

By far, the most stirring contribution to this tabooed subject was that of Bill Vogt given at the Montreal conference in 1955. While I was not there to hear and witness its presentation, I am sure the audience was spellbound. To the others who also missed it or who have not since read it in the *Transactions,* I would recommend it as a stimulant for some profound thinking—and to be avoided if you are troubled with insomnia.

The third paper in this group was that by Durward Allen read at the New Orleans conference in 1956. In "Resource Ecology—Neglected Discipline" Allen courageously challenged the desirability, or even wisdom of an ever-increasing economy. In driving home this idea he used language thoroughly understood by wildlifers. "If there is no more to life than living, if human beings are content to accept numbers as a goal and be produced like broilers in a battery, served for essentials by a completely synthetic environment, then our present course is the proper one. Possibly the perception of the average person can be so narrowed as to make that kind of existence possible. But there seems to be no good reason why it should."

Whereas I do not expect to see the time when, at a future wildlife conference, there will be, backstage, an enlarged portrait of Margaret Sanger, or, out in the corridor, the employment desk of The Wildlife Society replaced by a birth-control clinic, I do believe, in all seriousness, that the contribution of only three papers out of 1,777 does not focus adequate attention on a problem that is at the very root of our conservation difficulties.

But, in getting back to conservation at this conference, we again meet, headon, with the subject of my momentary digression. Greeley, in looking forward only 10 years, visualizes that our forests, wilder-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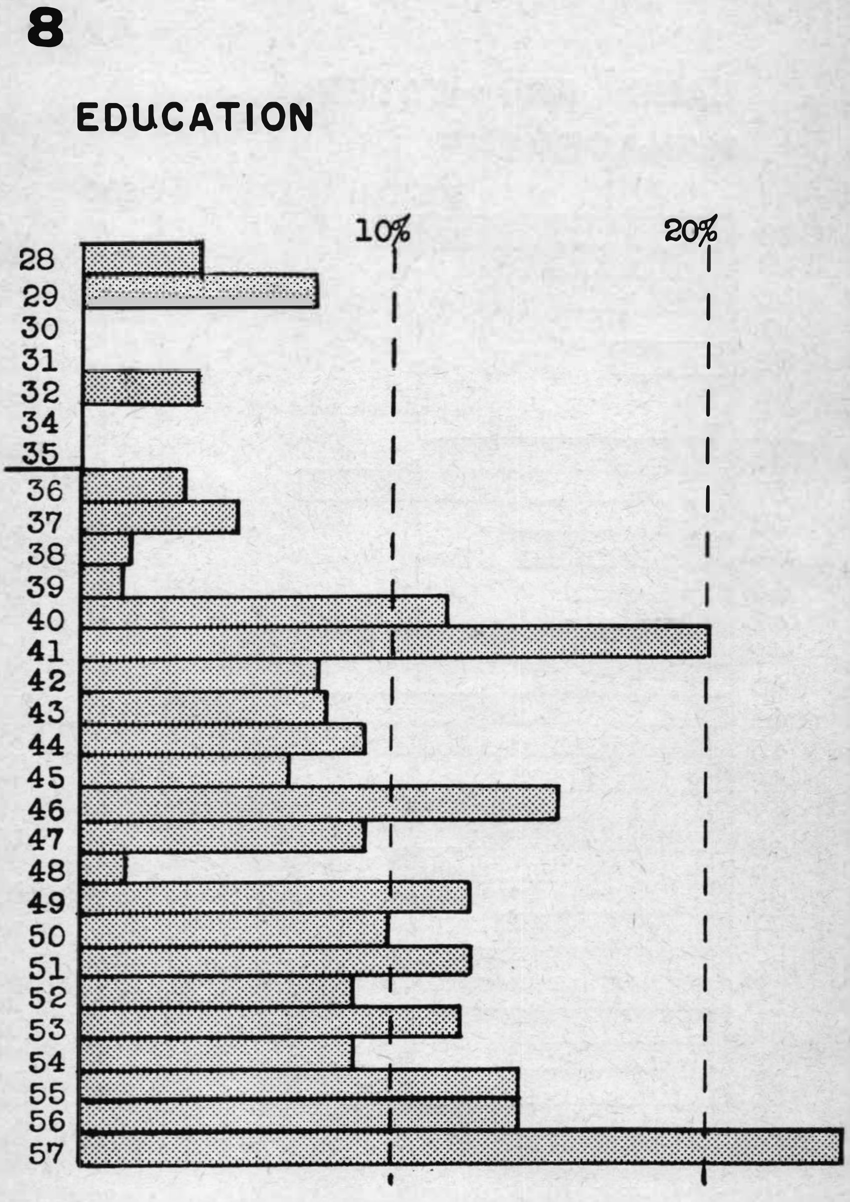
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ness areas, parks, public lands, and our waters will have to take care of the needs of 30,000,000 more people if the build-up continues at the present rate. If this is inevitable (and I, for one, do not think it need be) there is only one way, he states, to meet it. There will be more rigid application of the principle of multiple use in which regulation will increasingly supplant freedom of action.

Williams, also, prefaced his remarks with reference to the ogre of "standing room only," but he holds out hope for years to come by more intensified application of our knowledge of land and water management. Cottam, in discussing "Science and Resources," emphasized, with a variety of statistics, the difficulty of science keeping abreast of the needs of an ever increasing human population. Congressman Blatnik had pertinent remarks on the same subject.

The story of land- and water-management as revealed by this analysis is a highly fluctuating one, characterized only by a general increase of interest during and immediately following the war (Figure 7).

In this conference we have learned that the role of the soil chemist comes to the fore in Neeley's paper on "irreversible" drainage in which he describes the process whereby the soil of certain drained areas in the coastal region from New Jersey to Texas may have become highly acid for an indefinite period—too acid, in fact, for crop production and also for some of the more attractive waterfowl foods.

Lawrence, in his paper on "Wildlife Control Measures on Pacific Northwest Tree Farms," has given us a vivid picture of the successive hazards encountered by forest seeds and seedlings. Much of this stems from clear cutting which creates an environment favorable to most four-legged vegetarians from shrews to deer. He gratifyingly states that "the real challenge is not in the field of complete control by chemicals but in gaining complete understanding of ecological facts involved and putting this knowledge into practice." Some of the currently applied procedures had their inception in research carried out by the Denver Laboratory of the Fish and Wildlife Service.

Janzen gave us a hurried picture of the necessities and possibilities of water conservation and use—all against the frightening background of mushrooming human populations. A high point to many of us was his assertion that amendments to the Coordination Act have been proposed which would give fish and wildlife a status equivalent in all respects to that of other purposes. Because of their far-reaching implications, Jansen's comments on the chemical pollution of air, water and land through airplane dispersal of highly toxic pesticides, will demand the attention of every United States citizen, be he a farmer, an urbanite or roamer in the wide, open spaces. Unless this activity is placed under more rigid control we may be confronted with wildlife conservation problems never dreamed of 5 years ago.

The role of education in spreading the gospel of conservation has attracted greater attention through the years. (Figure 8). Little was contributed prior to 1940 but since then the subject averaged more than 10 per cent of the annual contributions. Last year the papers dealing with education comprised nearly a fourth of the total program. That this was not a flash in the pan is evident from the well-attended session on conservation education of the present conference.

Dr. Taylor has given us a reminder that conservation problems are not restricted to North America. Although the details may be different, the essentials are the same even in biologically unique Australia and New Zealand. If I understand his comments correctly, he urged an increased exchange of scholars and technicians between the United States and Canada on this continent and between Australia and New Zealand over there. With this worthy objective there can be no disagreement, yet I would strongly urge that, in North America, we extend a helping hand to the South where substantial portions of our waterfowl and other migratory species spend their winters.

And that brings to mind another point in conservation education: I refer to the educational requisites of wildlife technicians themselves who should become better acquainted with work being done in foreign lands. There is no single channel through which closer relations may be established in the wildlife field with Latin-American countries than through a proficiency to speak, read and understand Spanish. Industry has long recognized this fact: it is time that the wildlife profession fall in line.

Many of the problems associated with natural resources in the temperate zones of Europe and Asia are similar to those in North America, and there, also, the language barrier has hampered our understanding. All too frequently, after our awkward and embarrassing attempts to handle German, French or Swedish, we find our foreign friends charitably suggesting that we talk in English. A wealth of knowledge of resource conservation and management would be more readily available to us if we could overcome the linguistic hurdle. This fact was impressed upon me during the last war when, through facilities provided by the Office of Scientific Research and Development, numerous papers on the ecology and the control of field rodents (written in Russian) were translated and made available.

What a splendid opportunity exists for wildlife technicians, seeking advanced scholastic degrees, to locate, translate and prepare dissertations on important papers published in some foreign language. The subject matter should rightfully be restricted to their own chosen fields but the results could be a boon to all future workers.

Dr. Wagar questions the possibility of retaining rare wildlife values through educational processes now being employed. We, who know him, admire his staunch and sincere advocacy of the vigorous life in the out-of-doors and the enjoyment of natural resources without mutilation or destruction. However, the current wave of vandalism and littering is not confined to contamination of the wide, open spaces. It is probably more prevalent among those segments of society which never experienced what Wagar aptly refers to as "the wholesome leaven of Boy and Girl Scouts, Campfire Girls and Conservation Camps." Your summarizer feels that it is not the system so much as the lack or paucity of it which has brought us to where we are. Certainly Foster's figures on 4-H Club activities give impression that progress is being made and, if you still have misgivings you should have heard Heistand's paper on "Boy Scouts as Conservationists."

May I venture another thought? If we are failing with all that is being done at the levels of our universities, junior colleges, high schools and 4-H Club and Scout organizations, perhaps we may succeed if we (with tact and understanding) began at that formative and responsive stage, the kindergarten. It would have one definite advantage: we would be reaching a higher percentage of future citizens. White's paper on conservation education in a junior college and Lively's at our universities, both indicate that such programs are reaching only a fraction of the students attending.

Baker has given us a splendid resumé of changing conditions in northern Mexico. He suggested an educational program to acquaint the residents of that area with the necessity of practicing sustained-yield management of their natural resources, including wildlife. I feel that primary stimulus for this should come from a core of sound-thinking individuals south of our border, not from us, lest we assume the role of an ex-convict turned evangelist. What a gracious gesture it would be if, with financial aid from this side of the border, to defray the cost of bilingual interpretings and translations, one of these North American Wildlife Conferences could be held in Mexico City! Our meetings in Canada have been among the most profitable; a gathering in Mexico would not only be highly rewarding but an occasion long to be remembered.

As you may well appreciate, the classification of papers under the category of "Wildlife on Agricultural Lands" is fraught with much uncertainty (Figure 9). Some of those dealing with upland game birds, upland game mammals, and land and water management might, with equal logic, have been allocated here. This may, in part, account for the highly fluctuating story revealed by the graph.

With big game resources there is sustained interest (Figure 10). This morning's session produced seven more papers, most of them of concern to the technician. In Uganda, East Africa, Petrides and Swank have found that there is both scarcity and overabundance and, as in this country, failures to control hunting have led to game decreases in some areas; failure to permit hunting is leading to habitat destruction in others. Graham, through the use of exclosures, has shown that deer-browsing may mean radically different things depending on the vegetative complex. He feels that deer-forest relations may call for local variations in management even down to county-wide or

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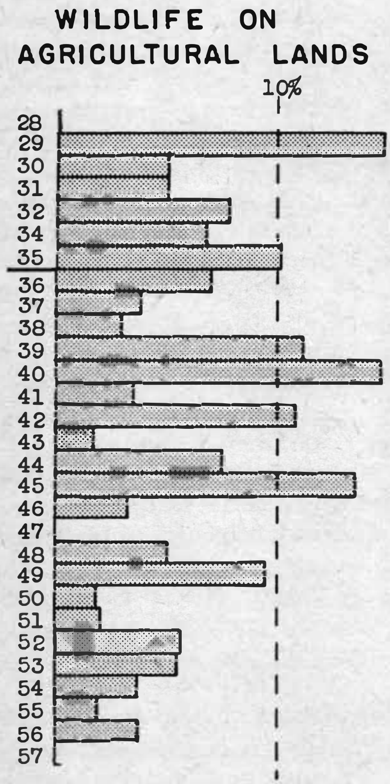

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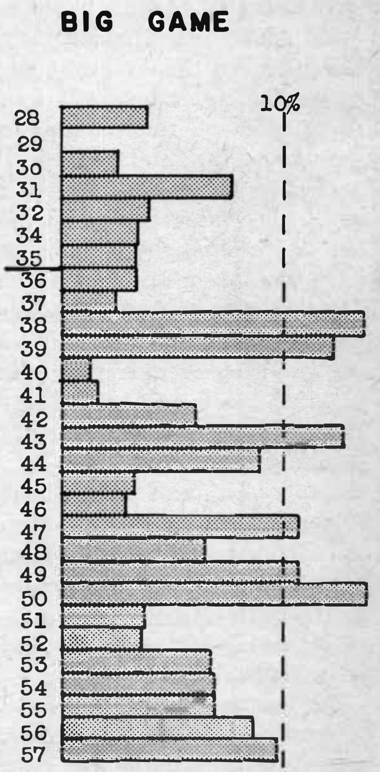

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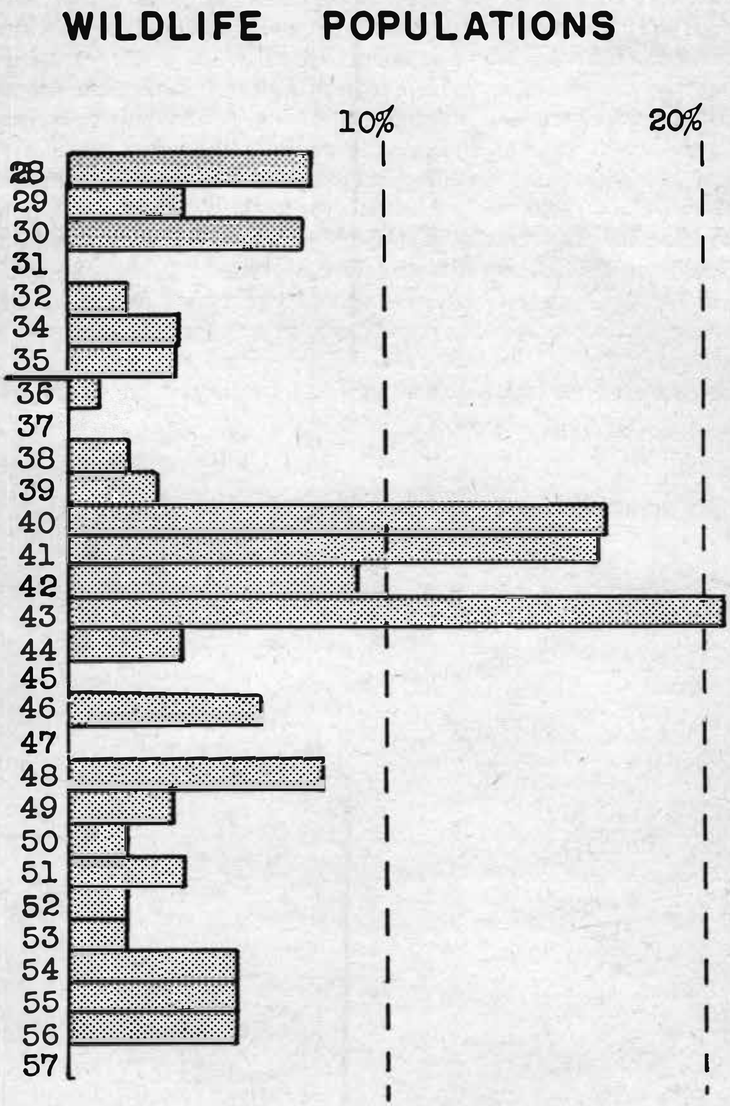
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smaller areas. Somewhat at variance is the idea conveyed in the Mohler, Shaw, Dalke paper to the effect that, in Idaho, there has been a trend away from special hunts and towards general seasons.

I have never seen such a mass of pertinent information on the black bear as that brought together in the paper by Black, based on research in New York State. When it is realized that 208 bears were captured in a two-year period and information assembled on such diverse aspects as capturing techniques, anesthetizing, dentition, sex, weight, age composition, minimum and maximum breeding ages, litter size, external parasites and pathological and parasitological examinations made on 43 of them, we get some idea of the volume of this research on a mammal not frequently subjected to such intimate study.

Papers on wildlife populations were prominent during the war years (1940-1943) (Figure 11). These dealt largely with utilization or, in a few cases, with control of overly abundant or injurious species. Perusal of the program of this conference discloses no paper which I would have classified under this heading, so let's hasten on to the one de-

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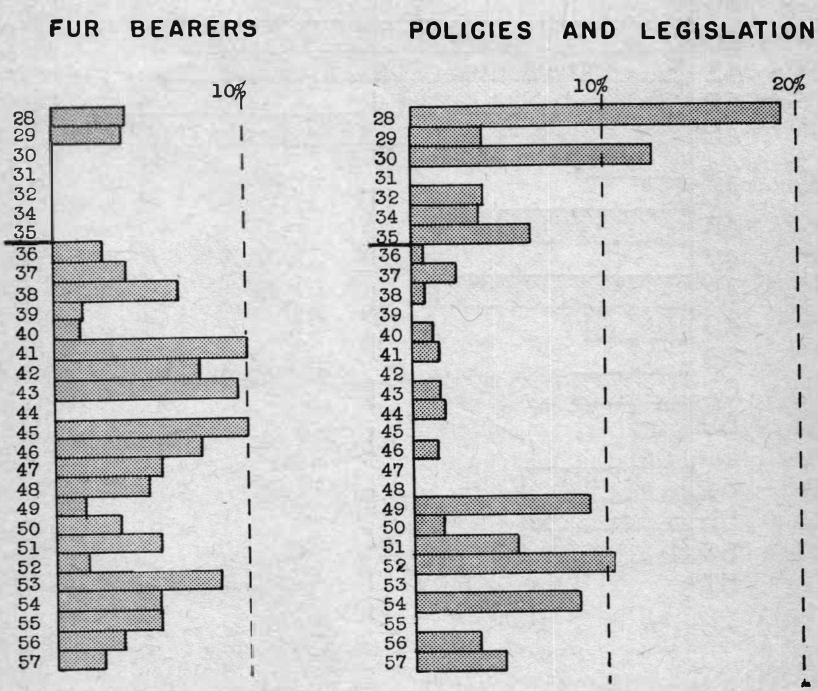

picting the trends in the category, "Fur Bearers" (Figure 12). There was emphasis during the war on the utilization of fur resources, although no paper was presented in 1944. The present conference also failed to discuss fur bearers unless the paper by Olsen on "Hookworms in Fur Seals" be classified there instead of under research in parasites.

"Policies and Legislation" (Figure 13), a pertinent segregation of subject matter, reveals an emphasis at the earlier conferences but with a marked drop-off during the war and thereafter, only to have interest revived in a fluctuating manner more recently.

In an analysis of this kind one is bound to encounter some oddities. We have seen both emphasis on, and neglect of, subject matter. I believe both State and Federal game officials will agree that the hottest administrative potato arising annually is the subject of waterfowl regulations. Yet, with the exception of a brief exposé of the flyway concept of waterfowl management by Lincoln in 1950, and a very informative paper by Crissey last year on "Forecasting Waterfowl Harvest by Flyways," we find nothing in the 1,777 papers at these conferences dealing expressly with the procedures used, and the reasons back of, waterfowl regulations. It would seem that, by early March, when these conferences are held, everyone has already blown his top about the current regulations or hasn't formulated his gripes about what should be done next season. It certainly does not mean that we know everything about the effect of various regulations. Who can say that, by reducing the daily bag by one duck we can safely extend the season a week or ten days? Does an added duck in the daily bag mean the same thing in waterfowl kill in North Dakota as it does in Texas? Are there not more facts to be learned about flyway migrations before sound flyway management can be assured? No doubt there is some information available on these matters but let's have more of it expounded at these conferences.[1]

Dr. Gabrielson has just given us another stimulating contribution in the crusade he has been leading for two decades or more—the administration of conservation agencies by men competent and technically trained to handle such jobs, fortified with the assurance that political considerations would not be invoked to wreck their programs. He also decried the system whereby state legislatures void decisions made by conservation officials supported by the expert advice of their technical staffs. Such things have happened even at the federal level, a

[1]Ruhl of Michigan pointed out that a dominant reason for the scarcity of papers on regulations is that one or more meetings, dealing expressly with waterfowl matters, often are held immediately prior to the Wildlife Conferences. The contributions to these meetings are not published in the Transactions being analyzed.—E. R. K.

dismal illustration of which occurred some 16 years ago when, by reason of a trite remark, both the appropriation and the authority to study the food of birds and mammals was deleted from the research program of the Fish and Wildlife Service. Despite all that was done by Dr. Gabrielson and others to correct this, that authority never has been restored. The result—a termination of one of the most important functions of that agency, the loss of technically trained men of long experience, the labor and cost of maintaining priceless, yet unused reference collections, and, in short, the failure of the Federal Government to meet its obligations in sound wildlife research and administration.

In concluding my remarks I wish to give support to "Pink" Gutermuth's earlier appeal for more comments from the floor. From what I could learn with one pair of ears functioning at only one place at the same time, I believe we have responded well to that appeal. Such commentaries often are more significant and thought-provoking than the original paper. No punches should be withheld if they drive home some salient fact in commendation or in constructive criticism. However, I would recommend stopping short of the situation that arose at one of the earlier conferences. The printed paper, dealing with one of the controversial matters of Federal policy, occupied less than four printed pages. The discussion, including what was essentially another paper, filled 29 pages of smaller type!

With that, you may now assign my review of this and earlier conferences to its proper category under the Kalmbach formula of program appraisal, or, if you wish, relegate it to that limbo of literary effort that should never have been thought of in the first place.

ACKNOWLEDGMENT OF APPRECIATION

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

Friends, it is believed that you will agree that this has been one of the most successful conferences held to date. After listening to that excellent critique and summarization by Dr. Kalmbach, it is easy to see why his colleagues in The Wildlife Society saw fit to recognize his many contributions to conservation by awarding him the Leopold Medal. He appraised the program of this large international meeting, and those of previous conferences, with the same meticulous care, and with the uniqueness, that has been evident in his life's work. I know from experience that summarizing a conference program is an arduous task. You did a splendid job, Ed, and in searching for appropriate words of praise, it makes me appreciate that this mere expression of thanks is inadequate.

In behalf of the Wildlife Management Institute, which sponsors these yearly conferences, I wish to thank not only Dr. Kalmbach, but all of the organizations, agencies, and individuals that contributed to the success of this year's meeting. We wish to thank the members of The Wildlife Society, and Robert M. Paul, in particular. While we are grateful to all those on the General Program Committee, which as you know includes practically all of the national organizations, I want to say Bob Paul did an outstanding job; he handled all of the preliminary details with thoroughness and dispatch, and the programs of the technical sessions reflect his efficiency.

Speaking for all of the conservationists throughout North America, thanks to the press. I have not seen a newspaper for several days, but understand that we have not had the coverage in the St. Louis newspapers that many of the conference papers merit. It is hoped that the wire services and other periodicals did better. We did everything possible to provide the local press with abstracts of papers, with copies of complete papers, and with prepared releases highlighting the talks of national significance, and if the local newspapers continue to disregard international meetings of this kind, I wonder how long St. Louis will remain as a leading convention city?

In your behalf, as well as that of the Institute, thanks to the Sheraton-Jefferson Hotel and to the St. Louis Convention and Visitors Bureau—there have been no complaints, and we are indebted to the Bureau for the efficient handling of the conference registration.

It was obvious that all of you enjoyed the banquet last night. This is a large ballroom, and it was filled to capacity. The musical and variety show produced by Jack Morton Productions was good, but we hope to do better next year. On the other hand, when I think of that banjo artist last night, it will not be easy to keep improving the quality of the entertainment.

The members of the Institute staff always are glad to see these yearly conferences come to a close. This makes 13 of these large international meetings that I have helped to stage, and now that this unlucky number is behind us, we can go forward with a sigh of relief.

Speaking of things behind us, makes me think of those patient, enduring, and gracious ladies that keep Dr. Gabrielson and me going during the months of preliminary planning for these conferences. Friends, this is one of my most pleasant privileges—to be able to ask Mrs. Gabrielson and my good wife, Bess, to receive their much deserved ovation.

In conclusion, the registration came up to expectations. We never can get more than 80 to 85 per cent of the people to register, and at the last check, there were 1,017 actually enrolled. We had 577 people at the banquet last evening, which constituted a capacity crowd. Although it would be nice to have everyone registered, the attendance record alone, as you know, is not the measure of the success of these yearly conferences. It is the over-all program, the interest and participation in the discussions, the related meetings, and the personal contacts that are made, that count most. Furthermore, if these conferences did little more than reflect the current trends in the important aspects of the work, and merely produced splendid appraisals like that of Dr. Kalmbach, these annual meetings would be justified.

Ordinarily, the time and place of the next conference is not announced until later. Nevertheless, this time I am privileged to say that we are going back to New York City next year. The headquarters hotel will be the Statler-Hilton (Pennsylvania) Hotel, and the dates will be March 2, 3, and 4. It is hoped that all of you will be there. Thanks, and a safe trip home. Happy landings!

REGISTERED ATTENDANCE AT THE CONFERENCE

ALABAMA

Ralph H. Allen, Jr., Mrs. G. A. Averitt, George A. Averitt, Dr. Maurice F. Baker, W. Walter Beshears, Jr., Paul Bryan, I. B. "Buck" Byrd, Wayne F. Colin, Verne Davidson, Mrs. Verne Davidson, Robert H. Dean, G. W. Fonder, Jr., Art Grumbine, W. L. Holland, Archie D. Hooper, Claude D. Kelley, Raymond D. Moody, Allen M. Pearson, H. M. Roller, Jr., Walter Rosene, Jr., H. S. Swingle.

ALASKA

John L. Buckley, Frederick Dean, A. W. "Bud" Boddy, Rolf W. Fremming, Maybelle V. Fremming, Nelson Urban.

ARIZONA

Fred Faver, O. N. Arrington, Steve Gallizioli, Paul Quick, Lyle K. Sowls, Wendell G. Swank.

ARKANSAS

Gus Albright, Harold E. Alexander, Wm. J. Allen, Mrs. Dorothy Allen, Robert I. Baker, O. D. Brown, Charles F. Cole, Nelson Cox, Bruce Crawford, H. S. Crawford, S. C. Dellinger, Aubrey Fowler, Sam Gooden, D. N. Graves, D. Leroy Gray, T. H. Holder, Andrew Hulsey, Douglas James, Wm. H. Julian, Bernie Lappin, Ray Martin, W. P. Mathis, Gene Rush, James Stevenson, Jerry Trenary, Harry R. Wieman, Thomas W. Wright.

CALIFORNIA

Paul Berg, David R. Brower, William Dasmann, George D. Difani, Ben Glading, Seth Gordon, Leonard G. Hummel, Robert Jones, Carl Koford, Mrs. A. Starker Leopold, A. Starker Leopold, Weldon L. Oxley, David E. Pelgen, Cecil Phipps, Robert Rudd, Paul Scheffer, Lowell Sumner, Chuck Yocom.

COLORADO

A. E. Borell, Mrs. A. E. Borell, Arthur H. Carhart, James Cole, Dr. Robert W. Davis, Richard N. Denny, John Greenbank, Ralph Hill, E. R. Kalmbach, Mrs. E. R. Kalmbach, Thomas Kimball, Wilford Olsen, Bill Reavley, W. Leslie Robinette, Harry Sims, J. V. K. Wagar, Jack F. Welch, Edward G. Wellein, Lee E. Yeager.

CONNECTICUT

Philip Barske, Richard H. Goodwin, David G. Powell, Lyle M. Thorpe, Oswald Tippo.

DELAWARE

William Baxcet, T. E. Doremus, Wilbert Rawley, Austin Smith, Norman Wilder.

DISTRICT OF COLUMBIA

Stewart M. Brandborg, Max W. Bridge, Bob Bridges, Gardiner Bump, Monroe Bush, Charles C. Butler, Charles H. Callison, Hiden T. Cox, James B. Craig, Walter F. Crissey, James E. Crosby, Jr., Frank Daniel, Peggy Emerson, George B. Fell, Ira N. Gabrielson, Mrs. Ira N. Gabrielson, Ed Graham, Dick Griffith, C. R. Gutermuth, Mrs. C. R. Gutermuth, James R. Harlan, Charles H. Heltzel, Michael Hudoba, Daniel H. Janzen, Robert M. Jenkins, R. E. Johnson, C. H. Lawrence, Daniel L. Leedy, Louis Lucas, James O. McClellan, C. W. Mattison, Lansing Parker, Robert M. Paul, Joseph Penfold, Daniel A. Poole, Harry Radcliffe, R. M. Rutherford, Carl D. Shoemaker, Mrs. C. D. Shoemaker, D. Harper Simms, James Stevenson, Richard M. Stroud, Ernest F. Swift, James B. Trefethen, O. L. Wallis, Richard Westwood.

FLORIDA

A. D. Aldrich, Mrs. A. D. Aldrich, Howard Bisslan, E. B. Chamberlain, O. E. Frye, Wm. B. Robertson, Don Southwell, Doris Southwell, Fred Stanberry, Durbin C. Tabb, Gene Wallace, Dr. H. R. Wilber.

GEORGIA

Dr. Paul Arnstein, Fred J. Dickson, Leonard E. Foote, Bill Greer, Roy Grizzell, Frank Hayes, Jim Jenkins, Howard Miller, George C. Moore, Henry Robert, Col. H. S. Russell, Emmett Shotts.

IDAHO

E. Kliess Brown, Paul Dalke, Kenneth E. Hungerford, Ross Leonard, Levi L. Mohler, Ray Sims, Mrs. Ray Sims.

ILLINOIS

George Arthur, William Ballard, Ira L. Banks, Edward M. Barnett, Frank Bellrose, J. J. Belz, George W. Bennett, Dale Birkenholz, Joselyn Blair, Don P. Bradshaw, Mrs. Nancy Bradshaw, Lee Bush, William Bushell, John C. Calhoun, James P. Carter, William H. Casey, Wm. F. Childers, William E. Cloe, John C. Cralley, E. E. Crawford, Murray Crowder, Joe Davidson, Mrs. Joe B. Davison, Wm. A. Eichler, Robert M. Eichler, Jack A. Ellis, Tom Evans, Lorne A. Fitts, Paul J. Frey, Arnold W. Fritz, William H. Funke, John S. Gasnell, Robert Gaylord, Harry E. Gearhart, Mrs. H. E. Gearhart, W. M. Gersbacher, C. E. Gillham, Robert Glesenkamp, Frederick Greeley, Mrs. Fred Greeley, Frank Gregg, H. C. Hanson, H. Gordon Hanson, George M. Happ, Mrs.. George Happ, Wm. R. Hawkins, James Helfrich, Robert C. Hilfibran, Robert K. Holz, William J. Hurth, W. D. Klimstra, Edward Kozicky, Floyd Kringer, Ronald Labisky, Ray Lane, R. W. Larimore, Joan Laubscher, Fred B. Lifton, James M. Lockhart, Forrest D. Loomis, Al Lopinet, Rex Lord, Max McGraw, Lewis E. Martin, Bill Mestel, Ross J. Miller, Jim Moak, Paul Moore, Carl Mohr, Bruce Muench, William Neff, Wesley C. Newcomb, K. Duane Norman, Hal N. Opperman, Glen Palmer, Grace I. Palmer, Paul W. Parmalee, Sam A. Parr, John D. Parsons, Clayton Phillippy, John Piazza, Dave Pierson, David P. Porter, Clarence Pratt, William L. Preno, Ora M. Price, Dennis G. Raveling, D. O. Rettinger, Dieter Rodrian, Glen C. Sanderson, J. Henry Sather, Norman F. Schlaack, Jr., Josef Schlunck, Thomas G. Scott, L. B. Sheffield, Jr., Paul Shepard, Hurst Shoemaker, William L. Skaggs, John H. Slachter, C. R. Spangenberg, Howard J. Stains, W. C. Starrett, Jerry L. Stegman, Walter O. Stieglitz, Harry Stiles, Marshall L. Stinnett, Don Stuckey, John Suchy, L. Gerard Swartz, Walter P. Taylor, Mrs. Walter P. Taylor, John S. Thatcher, Robert A. Urbanek, Jo Valentine, Ruth Valentine, B. J. Verts, Mrs. B. J. Verts, Paul A. Vohs, Jr., John Wanamaker, Maurice Whitacre, Robert Wolf, Jim Yoes, George Zebrun.

INDIANA

Durward L. Allen, John Allen, W. B. Barnes, George P. Graff, Charles M. Kirkpatrick, Ralph Kirkpatrick, Donald J. Leedy, Mrs. Donald Leedy, Calvin J. Lensink, Kenneth Marlin, Dale Martin, H. W. Moesch.

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Charles V. Bohart, Hank Bradshaw, Kenneth Carlander, Mrs. K. D. Carlander, Mrs. John W. Crabb, Lester F. Faber, Arnold O. Haugen, George O. Hendrickson, David T. Hoopes, Dr. A. N. Humiston, Paul Leaverton, K. M. Madden, G. H. Meyer, R. B. Moorman, Robert Pierce, H. Wayne Pritchard, Dudley D. Rehder, Sylvan Runkel, James C. Schmulbach, Mrs. Pat Schmulbach, Lawrence F. Small, Everett B. Speaker, Bruce F. Stiles, Ries Tuttle, Douglas Wade, Doris L. Weller, Milton W. Weller, Glen W. Yates.

KANSAS

Colin W. Brown, Charles Burner, Frank Cross, Jackson Davis, Donald A. Distler, James Elder, C. F. Gladfelter, George Halazon, Mrs. George Halazon, Dale Hill, Dave Leahy, W. L. Minckley, James Norman, Stanley Ratcliffe, Jerry Tash, Otto W. Tiemeier, Mrs. Otto W. Tiemeier, C. E. White.

KENTUCKY

Ed Adams, R. B. Allen, Charles Bess, Bernie Carter, Minor Clark, Francis W. Collins, James Durrell, Hunter M. Hancock, Robert Harris, Edgar L. Hartowicz, Joseph Hartz, William E. Hayden, Dennis F. Holland, Carl E. Kays, Louis A. Krumholz, Terry A. McFowan, Arnold L. Mitchell, Lee K. Nelson, Edward Penrod, Frank Phipps, Dan M. Russell, Don H. Strode, Tom Williams.

LOUISIANA

Ted B. Ford, J. R. Fowler, Leslie L. Glasgow, H. B. "Joe" Martin, John D. Newsom, Morton M. Smith, Royal Suttkus, Richard K. Yancey.

MAINE

George W. Bucknam, W. R. De Garmo, Howard Mendall, Horace F. Quick, Carl Sindermann.

MARYLAND

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