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of the

THIRTIETH

NORTH AMERICAN WILDLIFE AND NATURAL RESOURCES CONFERENCE

Conference Theme:

STATESMANSHIP IN OUR CHANGING ENVIRONMENT

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The Wildlife Management Institute wishes to express its appreciation to The Wildlife Society and to the many organizations and individuals who contributed to the success of the 30th North American Wildlife and Natural Resources Conference.

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GENERAL SESSION

Monday Morning—March 8

Chairman: Ernest Brooks
President, Old Dominion Foundation, New York City

Vice-Chairman: Jack McCormick
Chairman, Department of Ecology and Land Management, Academy of Natural Sciences, Philadelphia, Pennsylvania

PUBLIC RESPONSIBILITY FOR RESOURCE POLICY

FORMAL OPENING—THIRTIETH CONFERENCE

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

It is a privilege and a pleasure to open the 30th North American Wildlife and Natural Resources Conference. We are delighted to see so many people here at the opening and to see all of the familiar faces intermingled with the newcomers in the audience. This admixture of old friends, who have been attending these conferences for years, and those who are attending for the first time well represents the continuity and progressiveness that we strive for in these meetings.

The North American Wildlife and Natural Resources Conference always has been international, but its scope seems to broaden every year. This year I believe that we have people from all of the States, nearly all of the Canadian Provinces, and from Mexico, as well as a good representation from England, France, Italy, Switzerland, Africa, Australia, and other distant nations.

Those of us who stage these international conferences each year try to make the new one better than the last. This is not always an easy task, and it gets more difficult with each passing year. This time, however, I believe we have enjoyed at least a measure of success. We have an outstanding panel of speakers, including some of our most distinguished conservationist-statesmen, who will be introduced by the chairman of this session. We are delighted and highly honored that these long-time friends of conservation, such as Senator Kuchel and Vice President Humphrey, are present today. You can't get much higher than that!

The success of these meetings is not solely the responsibility of the program committee which selects the speakers, or of the distinguished gentlemen on the program. In large measure the success will be judged by the participation of the audience in the discussion periods. If any of you wish to question any speaker at the close of his formal presentation, to challenge his views, or to add pertinent supplementary information, that is your privilege—it is something we encourage. We hope that all of you will make full use of the periods allotted for discussion.

The floor discussion will be recorded as usual and will be printed in the published Transactions of the Conference. We have no restrictions on the discussion other than those imposed by the clock and by its pertinence and relevance to the subject under consideration.

For those of you who are attending this conference for the first time, we wish to add a word of caution and explanation. It must be remembered that this is a conference in the true sense of the word and not a membership convention. In this audience around you are many people who are officials of state, provincial, and federal agencies concerned with natural resource conservation and management, and officers and representatives of local, state, and national organizations and societies. They are here to confer, to learn, observe, discuss and debate, but for the most part, they are not authorized to commit their organizations or agencies to a particular position on any issue. Because of this, no resolutions of any kind can be considered or adopted, and the chairmen of the individual sessions have been asked to rule out of order any resolutions that may be presented. The passing of resolutions is left to the discretion of the individual groups here represented. We hope that the ensuing discussions will stimulate resolutions, but they will have to be made separately and apart from this conference after deliberation by the officials, boards, and members of the various organizations.

The Institute hopes that all of you, in the next three days, will get a broadened viewpoint and a new understanding of the problems that beset us in attempting to manage, restore, and administer the priceless heritage of natural resources. We trust that all of us will get some suggestions and ideas that will be helpful with our problems.

Before turning this meeting over to the chairman, I have a few important announcements. First, the Wildlife Management Institute is inviting the visiting ladies to be its guests at a ladies' luncheon in Trader Vic's at noon today. There is no charge, but those who wish to attend must obtain their guest tickets before 10:00 this morning so that we can make reservations. This will be a real treat, and we hope the ladies enjoy themselves.

The annual dinner of The Wildlife Society will be held this evening, and, again, you must obtain your tickets before noon at the Society's table.

We can assure everyone that the Conference banquet tomorrow night will be a sellout, and those wishing to attend should obtain their tickets as soon as possible to avoid disappointment. There will be no speeches—just a good meal, a lot of Washington celebrities, and a special musical and variety show. It is urgent that those desiring to attend any of these functions obtain their tickets as promptly as possible.

I now turn the opening general session over to the chairman, a distinguished conservationist, a good friend and one that I tented with on a safari in Africa, the president of the Old Dominion Foundation, Mr. Ernest Brooks of New York.

REMARKS OF THE CHAIRMAN

ERNEST BROOKS

Ladies and Gentlemen, conservation is an idea whose time has come. It is no longer the hobby of a few nature lovers. Its problems are becoming obvious to everyone. Polluted water, polluted air, automobile graveyards, the unplanned sprawl of housing developments, the effect of chemicals which change the environment in ways about which we know too little—these and other results of man's new tremendous power to disrupt the natural world in the name of progress are beginning to worry more and more people.

It is obvious that man has fulfilled the ancient directive to "be fruitful and multiply and replenish the earth and subdue it." Now, he must learn to understand the ecological consequences of his conquest. What sort of an earth does he want? This has become an aesthetic and moral problem as well as a technical one, and it cuts across all occupations and disciplines.

It enlists the concern of both the scientist and the humanist.

Incidentally, it tends thus to bring together C. P. Snow's famous two cultures. Its relationship to science and technology is obvious. It is equally the concern of the humanist and the artist who deal with values, with the quality and beauty of our lives.

All sectors of our society must be concerned in making the world we want. Our society is no longer primarily a rural one. Most of us live in communities rather than on the land, and as individuals we have little direct control over the changes taking place in the countryside. Community action, governmental action, and enlightened action by the producers of our material abundance are all required.

To meet the breadth of this theme, we have at this opening session of the conference outstanding representatives not only of conservation groups but also of industry and government.

I would like now to introduce to you our first speaker—but he needs no introduction. I will say only this—if today conservation is an idea whose time has come, if now it is the concern of many men, this was not always so. Over the years, and for many years, a few dedicated and knowledgeable individuals have been hammering away at the theme until they were heard.

Our first speaker is one of the most respected and knowledgeable of these men. There is no finer spokesman for the cause of conservation.

Ladies and gentlemen, Dr. Gabrielson!

FIRST THINGS FIRST

IRA N. GABRIELSON

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

At the 29th Conference in Las Vegas last year, I prefaced my remarks with the observation that "Looking ahead, the year 1964 offers considerable opportunity for conservation achievement."

I am sure you will agree that 1964 did bring substantial accomplishments. It was the harvest year when all of the hard work that had been done before suddenly bore fruit, and notable advances were made along the conservation front.

Even those efforts that failed of enactment benefited in the favorable climate of 1964. The widely supported proposal to expand and strengthen the Federal Water Pollution Control Program, for example, moved into a priority position for early consideration by the incoming Congress. Proof of this is S. 4, the revised bill to improve the federal water pollution control program that the Senate sent to the House of Representatives by a 68 to 8 vote in January. This vital conservation bill was the first major piece of legislation to win approval from either House in the 89th Congress.

The fact that a conservation measure moved first in the new Congress demonstrates much more than a carry-over of constructive interest from last year. More importantly, the encouraging outlook for improving the water pollution control program illustrates two factors that should not be overlooked in an evaluation of where the conservation movement stands today.

The first of these is that the concept of conservation—the rightness and reasonableness of provident natural resources use—has captured public imagination as it has at no previous time. This did not happen all at once, nor has the high-water mark been reached. But right now the forces of conservation have more knowledgeable and more effective allies on a national level than at any previous time in my memory.

All manner of citizens organizations, both large and small, have broadened their interest and activities in the conservation field. Some excellent public information and leadership programs are under way. All of us are receiving many more letters from interested persons who ask what they can do to help. Many candidates for political office, who once gave little more than a passing nod to conservation programs, now speak of specific projects and general natural resources concepts with seeming enthusiasm. The American people, they have found, are concerned about their country's soil, water, wildlife, and other resources. Conservation has become a potent political force, and we must never let the political leaders forget it for a moment.

Paralleling conservation's political emergence is a growing national uneasiness with the course of urban and industrial expansion. More and more people are beginning to believe that there must be better alternatives to progress and development than headlong dissipation of open space, defilement of waters and air and other destruction of aesthetic and material resources.

Here in suburban Washington and in metropolitan centers across the country where the problem already is acute, people are awakening. They are beginning to reject the notion that man's abuse of the landscape and resources should be overlooked in anticipation of profits and tax receipts. They are beginning to think instead that employment, taxes, and development are more properly the tools of progress and not the master. Uncoordinated and irrational development persists mostly on the exhaustion of resources, rather than on their rejuvenation and orderly use. Fitting man's use of the land to his mounting need for resources of all kinds is the most serious conservation problem facing this nation today. We have barely begun to break the surface.

Resources management is an unending task. Its various segments can be dressed up and flown under ear- and eye-catching slogans, but underneath it demands the diligent application of an ecological conscience, a conscience that recognizes the unity of all renewable resources and how the use of one affects the whole. Successful conservation is not a catchall, a banner that can be used to lend legitimacy to economic rescue operations, regional renewal, and the like. Rather, conservation should be a thoroughgoing and continuous process, broadly applied and with stability of programs, appropriations, authorizations, and planning.

As consumers of resources and occupiers of space, people are one of the most serious threats to their own future welfare in this country and in countries around the world. Their threat lies in a virtually unimpeded population expansion and the accompanying demands for living room, for food, and for endless other human needs and desires. In some countries population expansion is frustrating progress toward a more satisfactory life. In others it has made a satisfactory life impossible, and poverty and human misery are rampant and probably will remain so for a long time to come.

Here in the United States the national fertility pattern is such that the population may swell from the present 194 million to 360 million by the end of this century, a scant three decades away.

Population control is a delicate and controversial subject, one fraught with implications of many kinds. Yet it is a subject that must be faced squarely and soon. President Johnson touched on it in his State of the Union message when he said, "I will seek new ways to use our knowledge to help deal with the explosion of world population and the growing scarcity of resources."

Former President Eisenhower said recently, "The population explosion has become one of the critical world problems of our time. It threatens to smother the economic progress of many nations and endangers the free world struggle for peace and security. Greatly expanded public and private efforts must be undertaken to contain this human explosion."

Author John Gunther observed: "In many nations there can be no advance at all, for the simple reason that the great expanding mass of people, human mouths, will eat progress away."

Increasing population is an interaction of education, race, age, area of residence, unemployment, and many other factors. A single thread that joins them all—if there is to be some kind of regulation of total population—is an understanding of both the consequences of unregulated population expansion and the salient features of birth control itself. Many couples obviously understand birth control, but few seem to realize the serious threat of population expansion.

"About 85 percent of the couples in this country have effective control of their fertility in the sense that they definitely stop at four children," Robert C. Cook, president of the Population Reference Bureau, wrote recently. "They do not lack knowledge of birth control, but many of them subscribe to the current fashion in family size," he said.

Significantly, the ideal family of 1 to 3 children of a generation ago is being replaced by an ideal family of 2 to 4 children today.

"Perhaps it is time to recast our definition of high fertility, to consider the number of children a family can afford to raise well, both financially and emotionally," Cook said. "And isn't it time, also, to consider the well-being of the national family?" he asked.

Steps must be taken to acquaint all people with the consequences of an escalating population. The time to start is now, before the problem becomes acute, and it is encouraging that persons in leadership all over the world are beginning to speak out. Many more should. Some communities also are moving to make birth control information available to interested persons—not to force it upon them, but to make the knowledge available. Everyone involved in resources management should be aware of this serious problem, because successful husbandry of our resources encompasses as much the factors of demand as it does of supply. The one goes with the other.

A resources supply-and-demand situation that dramatically illustrates the insatiable pressures of a burgeoning population is that of controlling water pollution. Clean water is one of our most critical resources. Few major river systems have escaped its blight, and all levels of government have been derelict in taking appropriate, positive action to protect our limited water supply. Highest legislative priority should be given to the correction of this neglect, because polluted water is a threat to individual, community, and national well-being. Its abatement requires infinitely larger investments of time, talent, and money than we have ever given it.

Constructive steps toward better pollution control are S. 4, already approved by the Senate and now before the House Subcommittee on Rivers and Harbors, and other bills, including H.R. 3988, authored by Congressman John A. Blatnik of Minnesota, chairman of the subcommittee. Although S. 4 and H.R. 3988 differ in detail, they seek first to have Congress declare that the purpose of the proposed Act is to "enhance the quality and value of our water resources and to establish a national policy for the prevention, control, and abatement of water pollution." Conservationists favor H.R. 3988 because of its generally broader scope.

Both bills seek to create a Federal Water Pollution Control Administration in the Department of Health, Education, and Welfare, under the direction of an administrator who would report to a new Assistant Secretary. S. 4 would place only part of the program presently administered by the U.S. Public Health Service in the new agency; H.R. 3988 would transfer all departmental functions for water pollution control there. Both proposals would increase the dollar ceilings for federal grants to municipalities for the construction of sewage treatment facilities. Neither, unfortunately, seeks to increase the annual appropriation authorization for construction grants above the current and inadequate $100 million. Research and demonstration grants would be authorized for projects involving the separation of sanitary and storm sewers; enforcement procedures would be extended to pollution that interferes with the marketing of shellfish; and the Secretary would be authorized to prepare and to encourage the development of regulations for standards of water quality for interstate waters.

There is some understandable confusion about this latter point, but, in my opinion, water quality standards or criteria, or whatever they ultimately may be called, give purpose to pollution prevention efforts. They do away with the concept of dirty waters and give substance and meaning to the undefinable philosophy of keeping waters as clean as possible.

By supporting water quality criteria, I want to make absolutely clear that I am not advocating stream classification in any way that would involve the assignment of waste-carrying capacities to this nation's waters. Rather, I contend that present and known future demands for high-quality water for all uses require the monitoring of discharge levels, outfall by outfall if necessary, to see that the quality of the overall water source for all uses is neither destroyed nor impaired. The goal is to prevent wastes from reaching a water course rather than to seek to remove them after the water is contaminated. The standards should be upgraded continuously as new information and techniques become available. In the end we would have a system whereby it would be possible and mandatory for each water user to return his process of waste water to the source in a condition suitable for all other uses that may be made of water from that common source.

These efforts to expand and strengthen the federal water pollution control program deserve your study and support. They constitute a step toward putting the entire nation on the road to improved management of one of its most critical natural resources. I say it is a step because the Federal Government cannot and should not be asked or expected to do this job alone. Much more must be done by state and local governments and by industry. Right now, in New York State and others, there are some encouraging signs that State Government is going to shoulder a larger part of its burden. Some segments of industry also are beginning to speak in more positive terms.

The salvage and development of water and other natural resources figures prominently in the Federal Government's proposal for rejuvenating Appalachia. No one can possibly quarrel with the objective of that program, but there is growing concern that the approach now before Congress has not been carefully thought out. In far too many ways it contemplates the destruction of some of Appalachia's most valuable assets and scenic and wild-country resources for the short-term expedient of roads, dams, and other public works.

In many areas Appalachia is a fragile and abused land, its forests ransacked, top soil stripped and eroded, and streams polluted. No public works program, regardless of the dollar expenditure, is going to make a long-term contribution to Appalachia if its basic resources are ignored. The money that is spent for public works soon will find its way out of Appalachia, as it has done elsewhere in the past, and the potential of that region and the hopes of its people will remain unrealized.

Appalachia study committee reports make clear that much economic return is expected from mass recreation and tourism. Highways, spur roads, and scenic overlooks—3,350 miles of them, in fact—are proposed for practically every significant ridge in the southern Appalachians. Large and small dams are contemplated to catch and store water that is mostly too polluted with municipal wastes and mine acids to be good for very much from a recreational standpoint. Mass recreation centers would be developed, with many in areas already used for scattered and diverse kinds of outdoor recreation, because that is the kind of public recreation the economists and planners can measure best.

In 1961, 6 million tourists traveled the 469 miles of the present Blue Ridge Parkway and spent an estimated $60 million in the Appalachia area. But fewer than 4 million fishermen and hunters enjoying their sport in undeveloped sections of that same region, spent more than $350 million for goods and services that year. How much of this potential will the Appalachia developments destroy?

The wilderness and semi-wilderness country of Appalachia can be decimated as easily by ill-planned impoundments, highways, dams, and mass recreation sites as it can be by subdivisions and industrialization. The Appalachia program ignores the point far too much that these same resources can be made to contribute substantially to the regional economy without the expenditure of huge sums for public works.

For example, Frank Barick, chief of the North Carolina Wildlife Resources Commission's division of game, has estimated that wildlife in his state could add $100 million to the incomes of communities without the further investment of a single dollar. This can be done, he advises, by seeing to it that wild areas are not destroyed in the name of progress, by strengthening laws and regulations to increase wildlife production, and by expanding opportunities for its harvest. Other states have the same opportunities, but nowhere in the Appalachia reports do I find much emphasis on this aspect of the resources.

The point I want to make about any program that attempts a regional rejuvenation is that conservation needs are not automatically assured by the commitment of huge sums of money for the construction of public works. Exactly the opposite may be the case. Resources values may be impaired or destroyed by programs that lack an ecological conscience in their planning and execution.

For this reason I was pleased and gratified by the central theme of the President's recent message on natural beauty. In it, he calls for a "new conservation" that is more than "the classic conservation of protection and development, but a creative conservation of restoration and innovation. Its concern is not with nature alone, but with the total relation between man and the world around him. Its object is not just man's welfare, but the dignity of man's spirit.

"In this conservation," the President said, "the protection and enhancement of man's opportunity to be in contact with beauty must play a major role."

This really is not a new conservation, as all of you know. It is the concept of natural resources use and development that we have been urging for years. It is the concept that recognizes that dams do more than store water, that wilderness is a forest use, or that wildlife is a deliberate, rather than an accidental, product of the land. But it is a *new* and historic conservation, however, in the sense that this is the first time that an ecological presentation of conservation has been discussed so fully in a President's message to Congress. We all should be grateful for it.

To be put to its maximum use, this new concept of conservation requires a much better inventory of resources than we have yet, a more critical evaluation of supply and demand situations, and a greater concentration on emerging long-term trends. It will require all resources managers and administrators to look more into the future than toward the past.

Too few state wildlife departments, no matter what they are called, for example, are able to provide much usable information regarding wildlife, its present status, the outlook for its perpetuation, and the positive steps that appear necessary to prepare for the future. Only a handful of states are conducting research to contrast the extent and availability of wildlife today with the factors that will influence its distribution and utility tomorrow. Much too little is being done; yet the unavoidable conclusion is that much greater care, precision, and imagination are required in order to guide fish and wildlife operations in the years ahead. Merely striving to maintain the status quo, or simply ignoring the future, is not the kind of professionalism that successful perpetuation of these resources demands. Every state fish and wildlife department should initiate, maintain, and keep up to date a blueprint for future programs and developments. It should not have some other agency or group attempt to do it for them.

The planners under the land and water conservation fund program currently are involved in putting together a national outdoor recreation plan. The strongest or the weakest part of the plan, but certainly the most essential, will be the 50 state outdoor recreation plans. Its strength or weakness will come from the quality and breadth of the individual state plans. Each fish and wildlife agency already is confronted with the challenge of making the strongest kind of presentation for the inclusion in the state plans of constructive and realistic programs and concepts for fish and wildlife, or of forfeiting its responsibility to planners who may know little about these resources at all.

President Johnson and his advisers should be commended on the breadth of the natural beauty message. It is useful to all of us because it outlines many of the most urgent problems, while at the same time it gives us an insight into the Administration's feelings about them.

The listing of the seashore and national park proposals establishes a much-needed priority and will enable conservationists to mobilize support and to concentrate and to apply it where the most good will result. I am pleased, too, that the message calls for accelerated land acquisition here in the East by the U. S. Forest Service, where much more needs to be done to accommodate outdoor recreation and to improve forest and watershed management.

The assurance that the executive agencies are proceeding to process primitive and other suitable areas under the terms of the Wilderness Act is comforting. I am hopeful that none of the individuals here and the groups and organizations they represent will lose sight of the acute need for maximum preparedness for and participation in the public hearings that will be held in the process of submitting primitive and other areas for wilderness protection.

Decisions are needed immediately on what the National Park Service should be doing to save the very values that national parks were created to protect. Population pressures increase daily, and specific guidelines must be laid down for administration of the national park system. Developed recreational facilities, overnight accommodations, and servicing installations should be kept out of the parks as much as possible. Road-corridor zoning in parks should not be used except on an emergency basis, and maximum attention should be given to preventing man from usurping the natural scene.

I am personally encouraged with the endangered wildlife species program of the U.S. Fish and Wildlife Service. It shows that the agency is beginning to move in a direction away from being solely another game department. The Service's charter is not narrow and its overall program deserves to be more broadly oriented to the needs and problems of fish and wildlife resources of many kinds.

I hope that the Bureau of Land Management will not be delayed in implementing its land classification and multiple-use programs by the pending study of the Public Land Law Review Commission. BLM has been denied these authorities for many years, and it would be unfortunate if that agency were to be prevented from implementing them fully.

There are a few things that are very disturbing to many conservationists. There is concern that some of this country's greatest natural and scenic values may be lost in the name of conservation. The Southwest water plan, for example, represents a serious threat to the national park system. Attempts are being made to justify Bridge Canyon Dam on the grounds that it invades only a small portion of Grand Canyon National Park and Monument. I remind you that there is no hope to preserve the parks system if a small invasion is to be permitted every time someone sees a chance to make a "quick buck" or a government bureau an opportunity to build another monument to itself by spending hundreds of millions of dollars.

The fantastic Rampart Dam proposal in Alaska poses the greatest single threat to wildlife values of any project ever suggested in this country. Conservationists should never fail to point out that this proposal, if constructed, will cost billions of dollars in public funds and in resources that are destroyed.

I want to mention also the enthusiasm generated in many of us by the President's assignment of a review of the Potomac River Basin to the Department of the Interior and for his call for making the Potomac watershed a model of conservation use and development.

These are some of the things I believe should receive priority attention in the next few years. I have had to pass over many other deserving subjects, but these are some of the things that, if done, would help to put first things first.

RESOURCES OF PEOPLE

THOMAS H. KUCHEL

United States Senator (California), Washington, D. C.

A great conservationist and one of my most illustrious predecessors in the United States Senate from California, the late United States Senator Hiram W. Johnson, said on one occasion:

"Since man emancipated himself . . . men have been dreaming dreams for man and mankind, and it is the dreaming of these dreams that has marked the mileposts in human progress during all the centuries past."

May we not ask ourselves this morning, as conservationists, what are our dreams for America? Are they dreams of green forests, lush valleys, unpolluted rivers, burgeoning wildlife, clean air and mountains primeval?

Are they dreams of realistic and sensible utilization of our natural resources so that some of our fellow citizens can earn their livelihood in mining, in grazing, in timber, and in fishing?

Are they dreams of roadways spanning the continent, which are constructed not only to move people faster from place to place but also to enrich one's contact with God's handiwork as he drives across our beloved land?

Are they dreams of wind-swept skiers, carefree boaters, happy picnickers, energetic hunters and leisurely walkers?

Are they dreams of once raging and turbulent streams being harnessed to prevent flood damage, to provide hydroelectric power for the farms, homes, and factories of our nation, and to offer recreational opportunities which never existed before?

All these dreams, and many more, are shared by those who believe in conservation of the resources which belong to all our people, and which must be dedicated to the never-ending benefit of all our people.

For perhaps too long, we have emphasized the preservation of our natural resources, but we have not given adequate attention to bringing the benefits of conservation to 190 million people who are the beneficiaries of this heritage.

For perhaps too long conservationists have neglected the hopes and the dreams—and the needs—of the people in our cities.

There is a real need for the conservationist in America to share his own dreams, his own high code, and the benefits of his successful labors with his city-dwelling brethren and with the urban planners who are responsible not only for our urban park and recreation programs, but for city housing and city environment as well, if we are to improve effectively the quality of life for every family in our land. Conservation of American human resources should go hand in hand with the preservation of our natural resources. For contact with nature invigorates our people. It can, and it does, spiritually uplift us all, we who daily bog down in the busy work, tensions and the fast pace of an industrial society in this fantastic age of nuclear power and scientific miracles. Perhaps never before—as in the few remaining years of this twentieth century, as we reach out to the moon, the stars and beyond—has it been so necessary to re-establish, at the same time, our contact with the world about us—on the mountain tops and in the valleys and underneath the seas.

Let conservationists think about and work for open space in our cities and decentralizing some of the labor performed there to the countryside. That need be no affront to the better life, or to the precepts of conservation or of beauty. Let us remember aesthetic considerations as we construct suburban housing development and consider plans for re-creation of the central city. Let us devote ourselves to the tone and the tempo of American life wherever it actually may be. Let us concern ourselves with the quantity of wildlife and the quality of public life as well.

Difficult questions and complex decisions confront our people—and those you elect to represent you at the local, state and national levels—as we seek, you and I, to resolve the conflicts which arise in the natural resource area. Should decisions dealing with our priceless and often irreplaceable, natural heritage be made solely on the basis of how many people will benefit, in the short run, or even in the long run? Should these decisions be made solely on the basis of the activities of either an articulate and dedicated conservation or user group and without regard of the effects such a decision may have on the well-being of most of the people in an area or region?

I suspect that the wisest policy over the long breadth of time is to follow neither course exclusively but to try to seek out the public interest, the interest of the people, or what is the right thing to do as one sees it on each new challenge as it unfolds, regardless of the whims of the many or the failings of the few. Principles of sound conservation practices remain, of course, immutable, and they should be applied in a fashion best designed to preserve our heritage and thus to serve the people.

This, of course, is not an easy task, and one must often develop a thick skin, but hopefully not a thick head, to fend off the abuse which will surely come his way as he makes his choice. In the last Congress, for example, a small handful of irrigators accused me of being for the "ducks" rather than for the "People" when I successfully authored legislation providing Congressional sanction for boundaries of the Tule Lake-Klamath Wildlife Complex. As a result of this measure, the water in these great refuges on our public domain, which are the heart of the Pacific Flyway, will, for the first time, be regulated so that water levels within them will primarily be dedicated to enhance the wildlife in the area. When I worked for five years with colleagues in both parties to enact a measure to establish a Wilderness Preservation System, it was said by some user groups that we wanted to lock up our primitive and wilderness areas and throw away the key. However, that was not so.

For me, those choices were not difficult. Regarding the fullest possible development and utilization of our water resources, the choices are not so easy, as one seeks to balance the place and the benefits of flood control, hydroelectric power development, pollution abatement, navigation, recreation, wildlife preservation, scenic beauty and aesthetic considerations in a single multipurpose, reclamation, or public works project. Such choices are no longer limited to the semi-arid West, as concern with the adequacy and the quality of our water supply, for example, has become national in scope. Falling water tables, water rationing, inferior water due to stream pollution are as familiar to the Connecticut housewife as to the California farmer. Yet, we must act and act soon if we are to meet the needs of our people in this area.

Another basic public resource, at long last slowly getting our attention, is our vast reserve of public lands. The present statutory policy for our public lands stems largely from the needs and the requirements and the legislation of the 19th Century. There is a need for realistic and forward-looking criteria to determine the uses to which such lands might best be put to meet the very real needs of our people. That study is now being undertaken.

During the last ten years the population of the United States has increased by twenty per cent. Americans have more to spend and more leisure time. In the same ten-year period, recreational boating has increased 160 per cent, fishing 38 per cent, and hunting 29 per cent.

In addition, a great many other Americans who neither boat, fish nor hunt have a continuing interest in the outdoors and enjoy the more simple activities such as driving, walking, hiking, swimming, and picnicking. It is now estimated that by the year 2000, just thirty-five years from now, our population will double and the demand for recreation should triple.

Projections of the demand for electric energy, an important by-product of multipurpose water resource development, show that we will probably have three times as great requirements in 1980, just fifteen years away, as we now have.

How will these demands for vital resources and leisure needs be met?

The Senate Committee on Public Works now has under study proposals for the development of a plan to collect surplus water in the Arctic and, through a system of canals, tunnels and rivers, distribute it to water-scarce areas in Canada, the Western United States and Northern Mexico. In addition, this project, estimated to cost $100 billion, would provide a waterway from Vancouver, British Columbia, on the Pacific, to Duluth, Minnesota, on Lake Superior. The diverse channels would deliver water to the northern plains from Alberta to South Dakota, and increase the flow through the Great Lakes-St. Lawrence System. As the water would descend through the proposed system of storage reservoirs and canals, it would generate electric power to help meet our growing energy requirement and contribute toward the investment and the operating costs of the project. This is but one of the many projects under consideration ranging in cost from a few million dollars to many billions.

But the solutions to these vast and vital undertakings are not merely in the amount of concrete poured and the number of turbines installed but, rather, it is in the quality of ideas generated from a breadth of vision and from dedication to the American dream.

Last week, the Senate Committee on Interior and Insular Affairs, on which I serve, began consideration of a bill to authorize a more adequate national program of water research. I am a co-author of this legislation and I consider it vital to the national welfare. One distinguished witness discussed with us the possibility of capturing surface rain water and putting it to beneficial use. In Arizona, he told us, an average of almost 82 million acre-feet of water falls every year of which not more than between five and six million acre-feet of that amount is accounted for by stream flow and additions to the underground supply. Yet, for three decades California and Arizona have been engaged in a bitter legal and political battle as to the appropriate division of 7½ million acre-feet of water in the lower basin of the ever-dwindling Colorado River. I must observe, parenthetically, that there is now a growing hope that amity and good comradeship between these two great states will now replace their past unhappy disruption and that they will now begin to work together to solve their common problem of water shortage in the river, and also to build a basis for tomorrow.

Throughout much of the Pacific Coast, hundreds of millions of acre-feet of water annually waste into the sea. And then there is the sea itself with its untold treasures. What potential lies before us if we but effectively focus the intelligence of our people on solving these problems. Should we not, by public and private assistance in all parts of the country and at all levels of government, bring together the physical scientist, the biological scientist and the practitioner of legal, political and social science to work on such problems? Weather modification, saline water conversion, waste water salvage, surface water conservation—all these and many more require the dedicated attention of interdisciplinary researchers. Their successful solution also requires greater participation by the private sector of our economy and a more successful attempt, than has been true in the past, to apply the benefits of government-supported research and development to the solution of these problems.

Above all, the successful solution of these intriguing and many-sided public puzzles and, indeed, of hundreds of others in the field of conservation, requires your own continuing concern, your own study and your own actions as conservationists back home in your own counties, cities and towns; for it is there that decisions are being made on local bond issues dealing with water supply facilities, parks and recreation. It is there that a zoning board decision can be made with regard to establishing a new industry which could affect the water supply and recreational potential of your whole community. It is there that we must all learn to work together with people in other walks of life if we are to improve the quality of our environment. It is there that the availability of the people's resources for generations of tomorrow will be protected and committed to the highest use if the people bestir themselves sufficiently to participate in the decision.

I recall the words of Theodore Roosevelt when he said in 1908—"the prosperity of our people depends directly on the energy and intelligence with which our natural resources are used."

That, my fellow conservationists, is your and my challenge. If you meet it, then you can truthfully say that you have done what Hiram Johnson described as dreaming dreams for man and mankind and that you have succeeded in bringing those dreams into reality.

There is one more thought which I should like to leave with you. Last year I read in *National Geographic* an intriguing and romantic article. It told of the discovery in the State of California of the world's oldest living thing—the tallest tree in all this globe—a giant Redwood rising 367 feet toward the sky. That monarch and its neighbors must be preserved and shall be preserved.

This unique living thing was tall and sturdy when the Magna Carta was written and, so the article said, was a seedling before the birth of Christ. Secondly, Edward Markham was quoted in the article and he said of the greatest trees, they seem to be forms of immortality, standing there among the transitory shapes of time. This tree, still living, has seen the best in man and the worst; it has observed nobility and all through its long life it has seen the savage. Our hopes, our dreams, our prayers are there and tomorrow it may look down on better things and the transitory shapes of this day may then have improved.

In all the dreams human beings dream now, the majestic one is the golden one—the Golden Rule.

SIGNIFICANCE OF EFFECTIVE RESOURCE USE

FORD T. SHEPHERD

Vice-President, The Mead Corporation, Dayton, Ohio

It is, I think, a singular distinction for a representative of the paper industry to have a part in your 30th North American Wildlife and Natural Resources Conference.

Your theme, "Statesmanship in Our Changing Environment," focuses directly on a national situation requiring, I believe, new and concerted considerations as we reach mid-point in the "Fabulous Sixties."

Other speakers this morning have staked out the tremendous dimensions of "Public Responsibility for Resource Policy."

My subject, "The Significance of Effective Resource Use," presents an opportunity to discuss some results we have been able to achieve in our industry, and more importantly, these results furnish some needed direction for meeting the challenges facing us in the vast area of effective use of our natural resources

As we all know so well, our natural resources have not always had the full appreciation of all our people. This accounts, in some measure, for the slowness with which we have approached the utilization of some of our greatest resources in the first place, and then in the maintenance, in the renewal, in the conservation of our resources' capability to contribute to our well-being, to our growth and development, to our environment.

In our drive to better our standard of living, we Americans, blessed as we are with so much in natural resources, have not always taken the time to count these blessings.

The early settlers of this country decided that progress in civilization was to be made and that blood and sweat and the resources at hand were expendable in attaining that civilization. This must have been the beginning of the American ambition—the American drive.

Evidently, those who followed in the pioneering of this great country believed that same way, for they, too, concentrated their efforts on growing and developing as individuals, as communities, as states and as a nation.

The history of the United States is, indeed, a record of resourceful people using the resources provided by Providence to become the greatest nation on the face of the earth.

Small wonder, then, that in the lifetime of those of us here assembled, we have witnessed and participated in the continuation of the American drive to secure the biggest, the best, the most of the material things of life.

The significance of effective resource use is a story the South can tell so well and so proudly these days. From Virginia to Texas, the land of "cornbread and cotton" that was, is now the largest forest region in the United States. I've even heard it called the "Pulpwood capital of the world."

Those of you who live in the South, and especially those who are engaged in forestry there, know all about the "miracle" in the southern forests and the importance of that natural resource to your economy.

What better lessons in effective resource use can be found than the record of the South?

The Southern Pulpwood Conservation Association wrote a little book about this "miracle in the southern forests," and I want to relate the story it tells:

"In 1935 the nation's number one economic problem was the

South! In the depression-wrought pessimism of the mid-30's even many southerners believed it, too, and prophets preached a message of more economic doom yet to come.

"In the 1960's the whole nation knew how wrong was its 1935 view of the South's economic potential. What had happened? The most startling and yet one of the least known factors was the 'miracle' which had occurred in the forests. Gone were the acres upon acres of sunburned stumps, remnants of virgin pinelands, for the South was growing more wood than was being used. A simple analogy tells the story:

"The South started 1935 with 12 trees, cut 15 trees in the next quarter-century, yet still ended up with 13 trees in the 60's.

"Who disproved the prophets of death for the southern economy and the forests? Who led the 'miracle-makers'?

"They were the hundreds upon hundreds of professional foresters—pulp and paper industry foresters, state and federal government foresters . . . men who came to landowners as missionaries of forestry . . . men who urged fire prevention, scientific selection of trees for harvest, reforestation and other measures to achieve increased forest productivity . . . men who promised a market for trees which otherwise would never have been sold.

"Backed by an assured market, the 'miracle-working' foresters spread their messages well:

More than 12 million idle acres were converted into profitable forests.

Cooperative forest fire control covering 9 and a half of every 10 acres of southern forests was instituted—more than double the coverage of 1935.

The pulp and paper industry through continuing research learned how to utilize more kinds of trees and to use more of the wood from each tree."

This miracle of the southern forests has continued and since 1962 the pulp and paper industry has pumped well over a billion dollars into the economy of the South each year! That's over 20 million dollars a week! It is almost 3 million dollars every day in the week, Sunday included! This is $121,016.50 an hour pouring into the economy of the South every hour of every day!

And, all of this through the utilization of the resources of the southern forests which the 1935 prophets declared ". . . would not long be important to the South's economy."

Paper industry management does not claim that accomplishment as its own. But our industry furnished the incentive and a considerable part of the leadership for others to accomplish it.

I feel sure everyone will agree that this is a dramatic example of effective resource use. We will agree, too, that only conservation-minded, industrious and resourceful people could have accomplished the "miracle" of the forests and led the way in the South.

We in the paper industry are always profit conscious (we have to be) and our conservationist attitude in the use of wood is no exception. We just can't make a profit and waste trees—or any of our resources—at the same time. Profit consciousness and wastefulness simply are not compatible!

The significance of effective resource use stands out also in the experience of the paper industry in the management of another great natural resource—water.

Water as the principal component of our manufacturing process is just as important to us as wood is as our principal raw material. Both are essential. Indeed, these two natural resources are the life blood of our business. Without either one, we could not supply your needs for paper.

We require almost 5 billion gallons of water per day for separating cellulose from the non-fibrous constituents of wood, for making paper and paperboard from wood pulp, for steam generation and for cooling purposes.

And all but 5 percent of that tremendous volume is returned to the stream. Our net use or consumption is small by comparison to our intake.

And, just as interesting is the fact that the run-off of rain on the 50 million acres of woodlands owned or controlled by our industry amounts to six times as much water as the total intake of the paper industry for all purposes.

The industry's efforts in conservation of our water resources are highlighted by the fact that our water use per ton of product has been cut in half in the last 20 years. This trend of decreasing water use per unit of production is continuing. However, our greatest gains in this area are still in the future, I am confident.

The industry's sensitivity to the importance of effective water resource use and our positive attitude toward management of our water resources was demonstrated first in 1939 when the Sulphite Pulp Manufacturers' Research League was formed in Wisconsin and then, early in 1943 when 16 companies established the National Council for Stream Improvement in the pulp, paper and paperboard industry.

The industry's record of performance in forestry and water resources to date is well established. It speaks for itself.

Now I would like to speak directly to the point that has much to do with the effective use of our water resources. It is, indeed, one of the great challenges of the "Fabulous Sixties," and, of course, I refer to the problem of stream pollution.

As conservationists you are concerned with all phases of natural resources restoration and management, which includes the maintenance of the quality of our water resources.

And we, who are in the paper industry, are concerned with the availability of water both quantitatively and qualitatively for the purpose of carrying on our business.

You and we are dependent on the economic growth and development of all those things which contribute to our way of life, our well being and the growth of our national progress.

And, being people, we enjoy the same pleasures—fishing, camping, boating, etc., and we are concerned with all phases of resources restoration and management. In short, all of us are conservationists.

Fundamentally, then, there is every reason to believe that we are in agreement on the multiple needs for our water resources. And yet, when the question of stream pollution comes up, the "conservationists" are on one side and "industry" is on the other side.

The "debate" doesn't go very far before the sole issue is "Industry or fish". . ."sparkling, crystal clear water" or "filthy, contaminated, polluted water." In short, it is black *or* white, and that's all there is to it!

Why must it be that way? Why can't we recognize the "gray area" in between the black and the white?

Dr. Edward J. Cleary, who has guided the Ohio River Water Sanitation Commission since its birth 16 years ago said a short time ago in a discussion, "The Challenge of Water-Quality Management":

> ". . . On the one hand there are some who would tolerate an attitude of unconcern about stream pollution until a nuisance is created.
>
> "At the other extreme are those who assert that users of water should return it to the streams as clean as 'technically' possible.
>
> "Perhaps you might agree that somewhere in between these viewpoints on public-policy—which range from acceptance of foulness to aspirations for pristine purity—that an accommodation should be sought.
>
> "Our 'effluent' society is not confronted with a choice of absolutes—of clean water versus dirty water or of fish versus factories. What we are faced with is the challenge of making an efficient adjustment to conflicts in water use."

And, in the Senate Public Works Committee document—"A

Study of Pollution—Water"—June 1963, we find two facts which, in my judgment, summarize this whole situation:

> "The waters of our nation constitute one of our greatest natural resources and are involved in all aspects of economic growth and well-being.
>
> "Oversimplifying a very complex situation, the water resources problem confronting the United States from now on is one of making its relatively fixed supply meet a rapidly increasing demand by providing the right quantity of water of the right quality at the time and places where it is needed."

"Providing the right quantity of water of the right quality at the time and places where it is needed" is the job facing all of us. It is the great challenge of today and tomorrow.

The "60's" and the "70's," too, will indeed be "fabulous" if we can turn this challenge into an accomplishment.

The Senate document I referred to outlines the responsibilities involved for the States, the local governments, the industries, the universities and the Federal Government.

What are some of our shortcomings?

Well, one of them is our lack of understanding of each other's needs for water resources. We've all been too busy with our own problems to learn about those that affect our neighbors.

The greatest progress is being made in the abatement of water pollution in those areas or regions where the benefits, as well as the burdens, of the water resources are being considered in total.

The resulting attack on solving the problem is summed up in two words: "Sensible Management."

Regional water quality management is the result of the attitudes, plus the considerations, plus the realistic plans of the people who are directly involved and want to solve the problem.

Sen. Kuchel said it this morning:—

In my judgment, it can't be done by edict; it can and should be done by the constructive action of the people in the water resource areas and regions.

Effective resource use was never more important than it is right now. This is our common goal.

The paper industry has been a leader in stream improvement research and development. Accomplishments to date have been outstanding.

The magnitude of the industry's remaining problems will be a severe test of our scientific and engineering resources, our production resources and our financial resources.

We believe we have the leadership capability for our part of the job.

RESOURCES OF GOVERNMENT

THE HONORABLE HUBERT H. HUMPHREY

The Vice-President of the United States, Washington, D. C.

Gathered here in this great assembly in the nation's capital are some of the most peaceful people, some of the most constructive people who will ever come together at one time, and it is rather hard to realize, having said that, that we are about to rejoin a great struggle and, indeed, join in revolution. But the fact is that we are, and, our government is helping to lead that revolt.

I am speaking of the century-long war against the waste of our natural bounty—against the desecration and the uglification of our beautiful land. We meet in Washington, and of all the places that we need to have met, it's here, to add new fervor to the cause of conservation and development which, having reached a critical stage, needs your fire, daring and dedication more than ever before.

You have heard a powerful address from the minority whip of the United States Senate, one of the finest gentlemen in the Congress of the United States—a progressive-minded, forward-looking man and a real conservationist. And might I add that in this area of conservation there is no room for partisanship; all there's room for is dedication and constructive action.

We are here to talk about the conservation of resources. Of course, we emphasize what we call natural resources—those resources of land and water, of timber and minerals, of wildlife—but we are also here to emphasize the conservation of another resource—the human resource—because the land and the man go together.

I can say that this government and this administration, headed by President Johnson and with his partner, Hubert Humphrey, and his Cabinet and this Congress, is a conservation administration, dedicated to the conservation of natural resources and human resources and dedicated to their development for the good and the use of mankind. I am proud to be a part of this—proud to have stood alongside of your own resources managers in the ranks of this great conservation movement. This meeting holds much of the pleasure and nostalgia of a family reunion for me—we have been together on other occasions.

We have labeled our cause "conservation." To many, that term speaks only of the quiet glades, the smooth waters of Minnesota lakes and wild creatures that inhabit the forests. But some say—"Are we not a nation of builders? Nature is fine but now let's move on to important business." They are supposed to be the practical ones who say these things.

Well, we reply that buildings must stand on firm foundations, and in the long run this, our nation, has no business more important than conserving her great basic resource, the earth that sustains all life, because land and man should be and, in fact, are inseparable.

Resources are not fixed objects on a fixed plot, and resource conservation is not a matter of tending to a changeless garden. We apply this term of "resources" to whatever men demand from the earth at any given time. As these demands change, so must our concept of conservation change.

Oil was not much of a resource before the automobile, and wildlife today satisfies other hungers than those of the stomach. Nothing on earth is eternal or fixed. As an old Greek philosopher once said: "You cannot step twice into the same river, for fresh waters are ever flowing upon you."

The conservation movement in America must understand change —the ever-widening rush of these new waters—and that is what has expanded our movement from the dreams of a few idealists to a great national crusade. That is what makes it uniquely an American revolution, for we *are* leading a movement still unique in our national experience.

Conservation, as we know it, is an American phenomenon, born of social reform, weaned by a dynamic national spirit, and shocked to its maturity by recognition that we, the people, have defiled a bountiful and beautiful land. Conservationists are trying to demonstrate that free people can act in their own behalf, voluntarily, willfully, and can dedicate their lands, not to the profit of the few but to the good of the many. This is the principle—the good of the many, the greatest good for the greatest number—we want to reaffirm today.

Oh, but how slow and agonizing has been the establishment of this principle; how frustrating it has been to see private empires built on public lands; how hard to watch resources exploited to the point of depletion and how heart-breaking it has been to witness the assault on our wildlife and the withering of our land's natural beauty! And how painful, oh how painful, the illusion that the land was limitless and its products inexhaustible! Sometimes, we have acted like gluttons, just devouring all that God created. But then, how thankful we must be that the land was not easily pauperized, and how grateful for the courage and vision of those early conservation pioneers; because it was they who made possible the great progress that we are making today.

These valiant pioneers reminded us that a nation stands or falls on the firmness of its resource base. We meet today to strengthen that base. They warned that a peoples' spirit and its will to greatness can be sapped by a barren land, and we meet here today to perpetuate that spirit.

There is, my dear fellow Americans, something spiritual about conservation effort and dedication to conservation because a true conservationist is a steward of the Lord—he truly protects that which God has created. That's why I have always felt that the conservation movement extended far beyond the commonplace of politics, far beyond even economics. It is a communion of the soul, it is a unity of the spirit.

Now, these valiant conservation pioneers began what is indeed a call to arms, a war, a battle, against three malignant forces and masters. First, the overexploitation of the land and its products, an ancient adversary whose results through history had been decline and decay. You know it to be a true fact. Nations that have withered away into oblivion, into weakness and nothingness, first exploited their land, then exploited their people, and soon were forgotten.

The second malignant master that we must wage war upon is corruption of the landscape, the countryside, the highways, the wild and the scenic spots which denies us pleasure in the natural world. My fellow Americans, we ought to bow our heads in shame. Our beautiful countryside is being made into a junk yard. Don't tell me we can't do something about that; don't tell me that the Mayor of a city (I was once one) cannot keep his streets clean, his boulevards well cared for! Don't tell me that governors and legislatures are helpless to see to it that there are rules and regulations that prevent the defiling of the landscape! Or does America want to show that its main objective in life is the piling up of scrap iron, or of garbage pits or dump grounds? Have we no pride? I'd like to arouse in this country almost a feverish emotional outburst against this defiling of the countryside, this corruption of the landscape. The least that a people ought to have that live almost encased in asphalt and concrete is an opportunity when they leave the environs of the city to see nature and commune with God without having to look over a pile of worn-out automobiles.

There is a third malignant master that we need to conquer—the overgrowth and the underplanning of our cities, where population pressures damage not only the tranquility of our people, but the air they breathe and the water that they drink.

Once again I say that it is possible, through the enforcement of zoning ordinances and health codes, to see to it that our cities are more beautiful; to see to it that the landscape looks a little bit more as though we loved the land that is ours.

Now, more importantly, these early prophets led us to learn that our land is a community of all living things—not just a series of human subdivisions. We have learned (at least some of us have) that nature will care for us only if we care for it as a part of life within the natural context. This is our lesson—to learn and teach—and history will not forgive us for a failure for all the headway that we have made. Our greatest challenges lie ahead because our population is growing rather fast too.

By the year 2000 (and that's just around the corner) the population of the United States will be over 300 million people; daily water needs will increase from 345 to at least 560 billion to 600 billion gallons a day. Needs for agricultural products will double and if my friend Orville Freeman can last as Secretary of Agriculture until the year 2000, he will have licked the surplus problem—there will be no doubt about that.

In a country where people have ever more leisure time and, we trust, more money to enjoy it, the burden on parks and on recreation areas will double or triple. The number of big-game hunters, for example, could well grow from the present 6,300,000 in 1960 to well over 12,000,000 by 1980, if we maintain the species and the spaces for them to hunt.

Thus the forces that united us in the conservation cause will have to be replenished because the task is so much greater. One of these forces and, I think, the most powerful of all, is the love of our people for the land. Americans have always been people of the land and while building a nation—a great republic from forests and plains—the pulse of the wild, of the natural, of the native so to speak, beats in the American bloodstream.

While most of us today live, as I mentioned, in concrete and asphalt environments, we remember our youth—our own and our nation's youth—the time of the open land and broad horizons. My, how I like to talk about those days when I could walk down old Timber Creek out in South Dakota, when I could go pheasant hunting, when I could dream dreams like boys do! Like most of you, I knew this world as a boy, when I could be a Robinson Crusoe in my mind's eye and in my imagination, or a Daniel Boone, almost in my own back yard or at least in the nearby community. I sympathize with youngsters today, who are literally imprisoned in asphalt and concrete. Is it any wonder that there becomes a harshness in our society, a coldness at times? How can you really feel the sweetness and gentleness until you can touch the grass with your hands and toes? Do you remember when you used to like to go barefooted earlier than your mother would want you to? Do you remember how you would like to just feel the grass and you still do. Well, let's save some of it. Let's save some of it, for this memory. This imagination is something to be cherished, isn't it? But also to be encouraged and made possible as a memory for generations yet unborn.

But an opposing force was the American will to conquer this same land, to tame the wild; and loving this land, we abused it. Thriving on its challenges, we demanded total surrender and it took us long years to learn restraint and moderation, to teach ourselves to turn away from wanton waste. We were like that little boy who got into the watermelon patch—just dig into the heart of the melon, never mind nibbling close to the rind.

Meanwhile, growth, which was our goal and almost our ideal, became our nemesis. Our natural bounty allowed us to expand in huge but booming numbers, but even in a bounteous land, we can drain that bounty and drain it dangerously.

Witness the sprawling of our suburbs. People sought a cleaner and less confining life than in the cities. But, by their numbers, moving helter-skelter to the suburbs, without plan or without order, they often destroyed these very values.

Cities, the cradles of social progress, all too often became prisons for those who could not escape even to the less crowded suburbs. This afternoon I am going to be meeting with the mayors of the largest cities of this nation, and I'm going to talk to them about making our cities livable. Cities ought not to be merely bedrooms so that we can get up and go to work. Cities ought to be citadels of culture; they ought to be places that make life enjoyable—the thrill of the good life—and they should not be without the birds, the parks and the grass and the hills and the open spaces.

So you see, we seek now a new conservation, one of people as well as land and resources; one of metropolitan areas as well as open country. Our times demand it.

We enter a new phase of the continuing revolution in an urbanized, industrialized society. The first phase began when the great journey of Lewis and Clark lifted our eyes to the West; it reached fruition in the bold and strong hands of Theodore Roosevelt. It was Teddy Roosevelt who first consolidated Federal powers on ground broken by such men as Schurz, Marsh, Powell and Pinchot. It was time for awakening the American conscience, for recognizing that this land had limits after all for protecting public lands from ruthless exploitation. Teddy Roosevelt will be remembered, as will Governor Pinchot and others, not just for some of their political decisions, like the war on trusts and monopolies, but, more importantly, for their love of the land, for setting the example and for at least starting the fight to conserve our great heritage.

It was also time, and that time was growing short, to heed the words of John Muir. You will remember what he said: Everyone needs beauty as well as bread, places to play in and pray in, where nature may help and cheer and give strength to the body and the soul. That is some of the best therapy that you can have. We ought to repeat that time after time. Everyone needs beauty as well as brains, places to play in and pray in, where nature can help and cheer and give strength to body and soul. Sir Thomas Brown once said, "nature is the art of God." This is why I said before that conservation should have a religious impulse to it.

The conservation movement was carried a giant step forward under Franklin Roosevelt, who made it an instrument of public welfare with such projects as the TVA, the Great Plains shelter belts, the soil conservation program, the Civilian Conservation Corps. The spur of his leadership drove us to find better ways of utilizing our resources, new means of using and managing them, and he broadened the definition of what we mean by resources.

Then, during the post-World War II years, with our major attention still focused on international turbulence, our conservation forces had to be gathered anew for a new thrust and one that is now under way. And may I say that were it not for people in this room, right here, you and your leaders and your spokesmen, we would have lost this war, lost this fight for conservation. Because the war years, understandably took our minds off it. And in the post-war years of international tension and crisis, without you thinking of the land and human and physical resources of this country, we could have been like a ship without a rudder—lost, storm-tossed.

Our late, beloved President John F. Kennedy set the theme for this modern period when he told Congress in 1962, "We depend on our natural resources to sustain us but, in turn, their continued availability depends on our using them prudently, improving them wisely and, where possible, restoring them promptly."

Just one month ago, President Lyndon B. Johnson amplified the theme in his message to Congress on natural beauty, and what a beautiful message! "Our conservation must be not just a classic conservation of protection and development but a creative conservation of restoration and innovation. Its concern is not with nature alone but with the total relation between man and the world around him. Its object is not just man's welfare but with the dignity of man's spirit."

But whose business is this, I ask? Some in this great enterprise ask the same. Who should take the lead? Who should take the first step? Which is the longest journey?

This administration answers that the concerns of conservation are the concerns of every American in and out of government.

Nearly a year ago, in his first delineation of America's internal problems, President Johnson said that the solution to these problems does not rest on a massive program in Washington, nor can it rely solely on the strained resources of local authority. They require us to create new concepts of cooperation, a creative Federalism between the national capital and the leaders of local communities.

So we can no longer afford to think of conservation as the special province of conservationists or preservationists; nor is it the exclusive domain of our resource developers. It is clearly the concern of everyone.

Conservation is a patchquilt of needs and problems. The patches come in all shapes and sizes, but each is vital to the finished work. The true conservationist can no more ignore problems outside his narrow interest than the seamstress can leave out center patches because she is a specialist on edges.

The common thread running through all conservation work is a concern with this American land of ours—this American continent—using it for the maximum public benefit today while maintaining its value for the tremendous needs of tomorrow. Conservation today, more than ever, insists, therefore, upon cooperation between all levels of government and all segments of the population. But let us remember that this word "cooperation," like conservation itself, can be used by some as a pious title for uncooperative and unproductive ends. Even among men of good will, great injustices can be done in the name of good causes. Progress is often stymied by bureaucratic bickering, by questions of who owns the land and who is responsible for what job. We have spent more time arguing about that than we have about conserving.

I say that, where conservation is concerned, land titles are irrelevant. When a water table falls, it doesn't matter really who owns the surface; the important thing is to get the table restored, and that ought to be a challenge to us. Erosion and fire attack land without consulting the clerk of courts or the registrar of deeds or ownership records. All of us lose when one of us loses soil, or when a deer dies from a damaged habitat, or when the bass dies from water pollution. Our real question is not who owns it, not who should do it first, but who can do the job.

The job begins with this question, and this is where the public, private, local and Federal interests begin to merge. It was this philosophy that moved the recent 88th Congress to become the most effective Congress in history for conservation legislation, and I shall ever be grateful for the opportunity that I have had as a member of that Congress and as a majority whip of the U. S. Senate to help make that record. I know that in passing more than 30 important conservation bills in one Congress that the 88th Congress was responding to the will of the majority of our people and to the needs of this republic. As a result, we have today a whole new charter of conservation, a new Land and Water Conservation Fund to help states and cities preserve areas of beauty and health for the pleasure of all; and a Wilderness Act. This was one of my major proposals as a Senator. I can remember the heat we took. My, you would have thought that we were going to deny certain interests in this country a chance to make even a nickel. I was one of those fellows that was wanted. Yes, we took the early heat. They took a little bark off me once in a while, a little skin here and there, but I am happy to tell you that the bill is passed and the Wilderness Act will guarantee that future Americans will be able to touch the majesty of untrammeled land that our forebears knew.

Then there is the water research and planning fund to prepare for tomorrow's sorry needs, and we began construction on more than 200 water resource projects with 70 more scheduled for this year. More than 5,500 miles of new transmission lines and an increase of flood control funds by more than 50 percent was the record of that Congress.

A Public Law Review Commission to study the laws and the administration of our public domain and the Classification and Multiple Use Act under which the administrators can finally determine which lands should be retained in Federal ownership and which disposed of and then began long-range programs on the retained lands. Now, this act is creative federalism in action, for it demands the closest coordination and consultation between Federal and local authorities. Then, among the most important of all conservation acts, we have the Economic Opportunity Act, the War on Poverty Act, which establishes among many other things a Job Corps Conservation program with Job Corps conservation camps, a goal, I may say, that I set in 1957. My particular version of that bill went past the Senate three times, but on the issue of racism, human resources and natural resources was denied attention for year after year. Finally, in this last Congress, we passed the Youth Opportunity Act, we passed this Economic Opportunity Act, and we have set in motion today a tremendous new program that is going to benefit millions and millions of Americans yet unborn. Here is an example of how the conservation concept has expanded. By bringing young men, many of whom have never known the feel of earth or the shade of trees, to work on the land we do more than repair the damage that is done to the land; we believe that the land can help repair the damage that society has done to the youth.

We are in one of the greatest healing programs. We are binding up wounds that have been opened for far too long. And I can tell you, my dear friends, when I witnessed the opening of that first camp, when I read about it and when I saw all the films, I am not ashamed to tell you that the tears flowed down my face because I saw there young men that had never had a chance getting a chance. What bothers me is why did we wait so long? Why all this self-righteousness about the evil of our young and the delinquency of our youth while the adults bickered over how to get the job done? And today, my fellow Americans, we have room in these camps, in this first year for only a few hundreds. Yet over a hundred thousand young men already, have pleaded with this government, this rich country, for a chance to work in a camp. Youngsters who are 16, 17 and 18 years of age, are saying to camp counsellors, "This is my last chance; if I can't make it here, I will go down in defeat"; a step away from disaster, and yet we parade around talking about our stock market and our wealth, while we forget the real wealth of the nation all too often—the youth.

I will be eternally grateful to the President of the United States for his leadership in this fight. A National Youth Administration boy in his youth, a country school teacher, President of the United States. And he's made up his mind that this country is going to see to it that every boy and girl, regardless of race, color, creed or economic station, has an opportunity for the best education that this Republic can offer at any time in its history. That's the commitment of your President, and I hope it's yours.

What this country needs right now is a good shot of conscience adrenalin. Just get busy. Get these cities of ours rebuilt; get the illiterates taught; get the young men and women, and some of them older, who have no skills; get them some training. Conserve and develop human resources at the same time that you conserve and develop the great physical resources—man and the land.

Government's role, indeed its obligation, is to put this people power into action programs wherever conservation needs have been neglected. Always the need must determine the program's scope and shape.

Government's real reason for even being is the welfare of its citizens and with tomorrow's citizens threatened with a blighted landscape and environment, of congestion and ugliness. The government that fails to act swiftly and effectively will have failed in its sacred trust.

My fellow Americans, by the year 1980, 85 out of every 100 Americans will be living in large cities. We have to teach people who live in the cities to love the land that surrounds the cities and not to exploit it. We are going to have to teach one another to keep the water clean and pure. There won't be a river left in America that isn't polluted; I doubt that there are many now. The land of the sky-blue water! But the water in all too many instances is contaminated by man. Now we can't do this and be a strong country and be worthy of our heritage. Can we do less, I ask, than to pass on to the next generation the natural legacy that we were left? In fact, each generation owes a little something more to the one that succeeds it. Does man have a right to destroy that which God created? Or don't you talk about that in church, or at your family altar, or in the quietness of your own conscience?

What is it that gives us the feeling that somehow or another we have a right to destroy that which we say we believe came from the Divine?

President's Johnson's proposals to conserve that legacy is one of historic importance. He has asked Congress for sweeping programs to create open spaces in our cities—providing space for wild animals—protecting air and water from pollution—beautifying the highways—increasing our park and recreation systems—developing new systems of wild rivers and scenic hiking trails—reducing the harmful effects of pesticides—researching the still mysterious relationship between man and his environment.

By 1970, my fellow Americans, there will be 90 million automobiles on our highways—90 million! It seems to me that we have something to be concerned about in air pollution, in beautification. In short, this government is acting to insure that as we increase the quantity of our goods, we do not diminish the quality of our lives.

So now we have this new impetus—new laws and new proposals. It's time to put them into effect in a joint effort. To do this, we need foresight, hindsight, and we need some insight to see that our cause is a historic one. And that we must ride with the tide of history. Yesterday's traditions may be today's myths. Such is the legend of America, the horn of plenty. Such is the legend that all good comes to those who merely tend to their own gardens.

We conservationists cannot and do not claim to have a special pipeline to eternal verities but I think that we do have a moral mission to protect the dignity and the well-being of our people; and this requires more than federal funds and programs—money won't do it alone. It requires that Americans of all walks of life and interests speak out against complacency, against the mischievious idea that conservation problems will somehow be solved by someone else; for the problems will not be solved by someone else. We cannot let George do it because maybe George isn't there; maybe George doesn't even hear us.

And we are not going to let someone else do it either. We are going to have to buckle down and get going and do it ourselves, and I think we are firmly on that course. That's why I came here.

You who administer these conservation programs; you who outline them and feed them, you know your program goals; let us work together in moving more rapidly toward those goals. Be a little bit restless, be anxious to see that this job is done.

You who are missionaries in this vital cause of conservation, may I suggest that you work with a missionary zeal. Let us together in the love of this great land of ours, this America that we herald in that beautiful song, "America The Beautiful"—let us build our land into a cathedral of beauty and of conservation and then let us call all the people to its portals.

REMARKS OF THE SECRETARY OF THE INTERIOR AT THE ANNUAL BANQUET, MARCH 9

STEWART L. UDALL

Tonight we stand witness to one of conservation's rare and historic occasions. My pride that we have come to this significant moment is pronounced. Most of you know the provisions of the Land and Water Conservation Act intimately. And most of you would agree with me that perhaps a central element of this Act is its provision for entrance and user fees at certain Federal recreation areas. Payment of these fees gives the public a direct opportunity to help provide additional State and Federal recreation areas which we must have to meet the staggering demand.

The Land and Water Conservation Fund Act provides for payment of entrance and admission fees through purchase of an annual Recreation/Conservation Sticker. This sells for $7 and admits a car and all its occupants to all designated Federal recreation areas for a full year. We expect the sticker to become a recognized symbol of public concern with public recreation needs.

I said that tonight was one of conservation's historic occasions.

It is now my pleasure to sell Recreation/Conservation Sticker No. 1 to the personal representative of the President of the United States. The Honorable Lee C. White, special counsel to the President, is here to accept the sticker for the President. Mr. White, if you will step forward and give me $7, I shall be more than glad to hand you this Recreation/Conservation Sticker No. 1.

* * * * * *

And now I have a second honor. Many of you know that this 30th North American Wildlife and Natural Resources Conference has been the scene of the first public sales anywhere of the Recreation/Conservation Sticker. A number of you have bought the sticker at our table outside on the balcony.

I hope you recognize that this has been a special sale. It has taken place in advance of official announcement of the price and availability of the Recreation/Conservation Sticker. This advance sale has been provided because we thought it fitting that the first stickers sold should go to you "shakers and movers" in conservation. Further, it seemed an appropriate way to demonstrate the high esteem we hold for the dean of American conservation, Dr. Ira N. Gabrielson. I think all of you will agree with me that he ranks among the giants.

Gabe, we have prepared a scroll for you commemorating this first public sale of the Recreation/Conservation Sticker. You should regard it as our tribute for a job well done. Accept it with our warmest thanks.

GENERAL SESSION

Wednesday Afternoon—March 10

Chairman: S. DILLON RIPLEY
Secretary, The Smithsonian Institution, Washington, D. C.

Vice-Chairman: EDWARD G. ZERN
Director, American Motors Conservation Awards Program, New York City

TODAY'S OPPORTUNITIES—TOMORROW'S NEEDS

RESOURCES AND MAN'S FUTURE

E. A. CÔTÉ
Deputy Minister of Northern Affairs and National Resources, Ottawa, Canada

If there's a question implied in the title of my paper, it has a simple answer: man has no future if he does not use his resources wisely. The basic theme of the science of human life is that man, like any other animal, is inextricably associated with and dependent upon his environment. We are not self-sufficient.

At the lowest level of existence we must find food and water and materials for clothing and shelter; and, as well, we need space.

At our present level of existence, millions of us from cradle to grave obtain our food in packages, our water from taps, and our clothing off the retail rack. We select our shelter from an anthill of modular units set in an asphalt grid or encased in a concrete tower. Small wonder we forget that most of our food and much of our clothing are the products of our fragile soils; that water, indestructible though it may be, remains clean and useful only if we do not pollute it; and that wood, one of our primary building materials, is a living thing with a limited rate of growth and reproduction. And even if we remember the sources of our well-being, do we recall their limits?

To you who regularly attend these Conferences I have said nothing new, and I have grossly oversimplified the issues. But I make no apology for restating the message of Vogt, Osborn and others: for us, as resource managers, our dependence on resources must be a guiding principle.

Here in the United States you have wrestled aggressively with resource management problems for over half a century. Your approach has been an inspiration to the world and your knowledge and techniques have been borrowed and adapted.

RECENT CANADIAN EXPERIENCE IN RESOURCE MANAGEMENT

Canada is one area where the environment is different from yours (it's vaster, colder, rockier, and wetter) as is the socio-economic setting (we have more languages, more political parties, a smaller pool of investment capital, and no capital gains tax). (Incidentally, my characterization of the differences between the United States and Canadian environments and cultures was by no means definitive!) You may be interested to hear something of the approach to resource management in the Canadian context.

In 1961 the Canadian Government sponsored a national conference on renewable resource management called the "Resources for Tomorrow" Conference. Two years of preparation preceded the week-long conference, and the associated publications include over 1,000 pages of background papers and 500 pages reporting the proceedings of the Conference itself. The Conference brought together, for the first time, senior officials and ministers of all Canadian governments to discuss the problems of management of *renewable* resources, each in the context of all the others. The effects of that exercise are still being felt in the total approach to resources which is becoming the predominant pattern in our country.

The Conference was guided by a committee of resource ministers, one from the Government of Canada and one from each provincial government. That body became corporate soon after the Conference and is now known as the Canadian Council of Resource Ministers. It meets each year to discuss resource problems and coordinated action for their solution. The Council is now engaged in planning a national conference on pollution of water, soil and air to be held early in 1966.

NATIONAL RESOURCE MANAGEMENT

If a national policy in Canada is to have any real purpose or substance, then all of the primary resources—and not just an arbitrary few of them—must be accorded federal attention. In the broadest sense, therefore, the federal interest includes all resources occurring naturally in Canada whether on its land, in its water, or in the air above. Of course, many different groups, agencies, levels of government and others have developed specific knowledge—and have clear responsibilities—in most resource fields, and we can be fairly confident that they are discharging their functions in an efficient and useful way. Only the Federal Government, however, has the obligation (due to its overall responsibilities in the realm of nationhood, to its responsibilities for international trade, commerce and the nation's welfare,) to correlate, to co-ordinate and to synthesize these many and varied approaches into an overall national essence.

Minerals and petroleum, of course, are two of the resource groups which command attention. Another is water, an element that is basic to the very existence of life. While the Federal Government concerns itself with both fresh and salt waters, I am particularly proud of the prominence which my own department has been gaining in research involving Canada's inland water resources. As you know, various parts of Canada are repeatedly being troubled by shortages or excesses of water. We can expect the importance and value of Canada's fresh waters to increase substantially over time. Water serves us all in a great many ways, as in industrial, agricultural and recreational use, for the generation of power, as a habitat for various kinds of aquatic life, and so on. In fact, even now water is probably already the single most important primary resource which we have in Canada. It is also of some not inconsiderable interest to the U.S.A. We foresee an early need for substantially more research centered upon the characteristics and availability of water. To meet this need, my department, with the approval of Cabinet, is already embarked upon a plan to double its engineering, technical and support staff within the next five years.

In Canada, we are now embarking on the development of the resources of the continental shelf. The Federal Government is facing today the crisis you met some 10 years ago in the field of control over these resources. Indeed, in December, 1964 the Government of Canada decided to refer the matter of jurisdiction (whether it is legally that of the national or provincial governments) to the Supreme Court of Canada for a decision.

Canada's forest resources are particularly magnificent and prominent. They provide another important subject for federal attention. Forests, like water, have many nationally significant values which you know all too well. Forest products industries flourish in many areas, and result among other things in an export of newsprint, kraft paper and other wood products which collectively provide a very substantial earning to Canada in foreign exchange.

However, national focus is not merely placed upon the crops which grow upon the land and on the minerals which nature has deposited beneath it. The land surface itself is an extremely important national asset. The use we make of this surface will determine the kind of country we pass down to future generations of Canadians. Often, in the past, our human use of land has been destructive or wasteful. Witness, for example, the poverty which now prevails upon many of our sub-marginal farms. Some of these lands were once bountiful, but now they no longer produce enough to provide their owners with a respectable livelihood. The need for improved farm economics has led, as you know, to the federal establishment of an ARDA program—and this program, I am happy to say, is already beginning to show concrete results in a number of different parts of the country.

NATIONAL RESOURCE MANAGEMENT, PARKS AND WILDLIFE

During the past few decades it has become increasingly more difficult to set aside and to retain specified parcels of land for use and enjoyment by Canadians now and in the future. Only 2% of Canada's land mass is dedicated as National Parks. The guardians of Canada's National Parks' land are faced with strong and continuous pressure from industrial groups seeking to extract as much short-term value from as many of our natural resources as possible. Now, near our urban and industrialized areas in particular, we find ourselves confronted by a growing requirement for recreational land, and a diminishing availability of land of a suitable kind. Already—despite broad open spaces lying beyond ready access—the need has become urgent to preserve parts of our national heritage against excessive encroachment or destruction.

A keystone of the new federal park policy, announced by the Government of Canada in September 1964; is that no industrial operation based on the use of primary resources can be permitted in a National Park. The natural resources of a National Park are deemed in optimum use when they are contributing to public enjoyment and education.

With our national population and the world's population growing at so rapid a rate, we simply cannot afford to depreciate the real value of the most aesthetic features of our natural birthright. We cannot as a nation ignore the requirements for fresh air to breathe, for clear, unpolluted waters in which to swim, for quiet natural sanctuaries from the mechanical, artificial environment of everyday communal life. A country as large as ours and so endowed with physical riches, owes its children the opportunity to experience the wonders of nature and the health-giving bounties of the natural outdoors. Tomorrow's children are as entitled as we are to walk through a forest, to watch a wild animal, and to gaze from a mountain-top at the handiwork of a million years of geologic time.

As you know better than we do in Canada, resource management on a national scale creates a requirement for planning future use of land and resource endowment. Plans are being formulated now—at the provincial and federal levels—to maintain suitable habitats for various species of wildlife, to establish parklands within easy distance from heavy concentrations of population, and to decide what portion of our total natural resources is best saved to serve recreational needs such as sport fishing, hiking, nature study and boating. Life will avail us little, if our financial greed leaves us emotionally and spiritually crippled or dead.

We, in Canada, can, however, follow the example set by President Johnson in his recent congressional message when he said, "For centuries Americans have drawn strength and inspiration from the beauty of our country. It would be a neglectful generation indeed, indifferent alike to the judgment of history and the command of principle, which failed to preserve and extend such a heritage for its descendants."

Faced with the prospect of an increasing volume of outdoor recreation in the years ahead, the Department of Northern Affairs and National Resources is tackling the problem of the relatively diminishing recreation space on two fronts. *Within* the area of existing National Parks it is attempting, through planned development and the introduction of a zoning system, to expand the areas of each park that can be used conveniently by the public. *Externally*, it is co-operating with the provincial governments in expanding the National Park system and in working toward a nation-wide heirarchy of public recreation lands that will serve any future demand.

Let me mention our plans for the National Parks. Whatever must be done to accommodate present and future public demand must be done in accordance with the primary responsibility the Federal Government bears to preserve the areas unimpaired for the use of the present and future generations of Canadians. This is both a statutory and a moral obligation.

The basis of the long-range plans for each National Park in Canada is a distribution of park areas into zones. The main classifications of zones will be *wilderness,* that is areas whose natural features would receive maximum protection and where developments will consist of only the minimum of public access by trail, and *semi-wilderness*, where the natural scene will be preserved by concentrating campgrounds, recreation areas, commercial accommodation and other concessions in limited area visitor-service developments.

My Department also has a responsibility for national interests in wildlife as well as recreation. At another session of this Conference, Dr. Munro outlined for you some of our thinking and plans for increased activity in support of the migratory bird resource which is of such importance to both our countries. I need not repeat what was said here yesterday, but I do want to point out that our proposals to begin a program of habitat preservation, to inaugurate a national kill survey, and to step up our migratory bird research are part and parcel of our intention to look after our resources so that we can all continue to use them for our benefit and enjoyment.

CANADA'S RESOURCES AND INTERNATIONAL TRADE

In terms of natural resource endowment, Canada is one of the wealthiest nations of the world; in terms of resource development and management, we still have a long way to go. As is well known, we have always been dependent on the export of our primary products for our national livelihood. In fact, Canada's trading importance is the main reason our country has gained its rather significant international stature. At last count, we are the fifth largest trading nation on earth.

Another federal role in Canada is in formulating and directing incentive programs to encourage the exploration and exploitation of our resources on a national basis. Perhaps the most important of these incentives are those which bear upon corporate taxable income. Three important incentives are now available in the field of non-renewable resources: namely, the tax exempt period, the capital cost depreciation allowance, and the write-off of exploration and pre-production expenses.

Fiscal incentives are only one means which the government has introduced on a national or industry basis. Others involve, for example, government provision of adequate transportation facilities by its construction of railway lines, air routes, Trans-Canada and other highways. Federal assistance is also provided towards the marketing and shipment of the country's primary resource production.

For their part, the provinces of Canada (which have a primary responsibility for the actual development and administration of resources) are promoting the development of their resources in quite a remarkable way. As a "horseback guess", I believe that at least

$2.5 billions of new capital will be invested in Canada's primary resource industries in the next 8 to 10 years. British Columbia alone will account for about $1.25 billions in pulp, lumber, power and water conservation projects. The volume of foreign and Canadian capital investments in the development of resources is impressive. The main investment appears to be in renewable resources. However, oil, gas, nickel, lead and zinc, iron ore, potash, tungsten and asbestos loom large in the fields of capital development—both exploration and development.

Canada's resource industries and related other sectors of the economy will collectively require a strong continued inflow of development and expansion capital if they are to continue growing at a healthy national rate. Heretofore, Canadian investors have been somewhat reluctant to lead the way towards developing and harvesting primary resources. Instead, they look to government—and especially to outside capital—to provide the necessary leadership, while putting their own money into bank accounts, insurance policies, real property, blue chip securities, etc.

Altogether, therefore, only a small portion of Canadian accumulations of investment capital have flowed towards private resource enterprises in the past. And there is not much likelihood that prevailing habits will change very much in the foreseeable future. The one conclusion that seems to me inescapable at this point is that much of the capital needed to foster a healthy resource industry in Canada will have to come from abroad, as in the past. We can consider ourselves fortunate that substantial private sources of funds abroad are both better able and more willing to take an investment chance on our resource potential than we are. United States investors are obvious sources of funds, and their contributions to the growth of our economy will continue to be welcomed.

Turning to the field of invisible exports, such as tourism, revenue to Canada from United States and overseas visitors amounted to approximately $602 million in 1963. Most of that revenue is attributable to our recreational resources. The input of foreign money from the tourist trade is as useful to the nation as that resulting from payment for exports, and thus there is a national interest in maintaining the saleability of our recreational resources.

At the same time, Canada is facing up to the need to rapidly develop secondary and tertiary industries based on its primary resources. Increasingly, Canada must develop its ability to process raw materials in Canada and deliver finished products to the world markets on a competitive basis. As you know, being one of Canada's best customers, over 25¢ of every Canadian dollar must come from exports.

SUMMARY

To sum up, I would like to leave the following thoughts with you.

1. Canada is bountifully provided with renewable and non-renewable resources.

2. These resources cannot remain undeveloped indefinitely and must be put to the best use, first, of Canadians and, concurrently, of the other people of the world.

3. The Government of Canada is pushing forward vigorously in delineating these resources and in creating favourable conditions for their exploration and exploitation. Canada and its constituent provinces are moving ahead to manage these resources in the best way we know how and we welcome U.S. and other capital to make these resources available and, increasingly, to process them in Canada for world markets.

4. Canada is fully aware of the many values ascribable to renewable resources, be they water, forests, parks or wildlife. In this field, all levels of government to-day are conscious of their responsibilities to preserve and use these renewable resources wisely for the benefit of Canadians and of their neighbour to the South.

5. And, lastly, the preservation of natural resources—birds, the flora, fauna and great natural beauties of Canada—is considered by the Government of Canada as being of prime importance not only for the recreational and healthful benefits but also for the mental and spiritual values which a young nation must keep always in sight if it is to continue its growth as a useful member of the society of nations.

DISCUSSION

DR. D. H. PIMLOTT (Canada): It was brought out at the Resources for Tomorrow Conference, that one of the great lacks in Canada is that of a National Recreational Policy. Therefore, I would like to ask Mr. Côté if there is any movement in Canada towards the development of either the National Recreational Policy or some kind of cooperative federalism policy in the area of outdoor recreation apart from that of our National Parks?

MR. CÔTÉ: That is indeed a good point. Here I would like to say that we do not have a recreational act and it was considered that it did not suit the general purposes of the tract that you have in mind.

Now, you are quite right in asking what we are doing about our outdoor recreation generally. If we are turned down on the flood control program, and there is no alternative from the recreational viewpoint, are there any moves in the wind now? Well, the answer is "yes" because, first, as a result of the Resources of Tomorrow Conference, there has been set up, on a continuing basis, a federal provincial parks committee which meets every year; one year on the technical side and another on the technical and policy side, to try to develop a better understanding of the roles played not only by national parks but by provincial parks and municipal parks. We have considered the question of outdoor recreation.

As to a national policy, the government is not in a position at the moment to have an over-all blue-print. However, we are working on something.

Also, with regard to the private sector, there was established last year a National and Provincial Parks Association which, like your own association in the United States, will tend to mobilize public opinion and mobilize the legislatures at all levels of government to move in the field. I say again that there are clear indications that we are moving in that general direction, but there is no plan that has been established or is ready for announcement at this moment by the Government.

RESEARCH AND EDUCATION FOR TOMORROW'S NEEDS

ERNEST J. NESIUS

Vice-President, West Virginia Center for Appalachian Studies and Development, and Director, Cooperative Extension Service, West Virginia University, Morgantown

Man's wisdom in the use and management of nature's resources will determine his future: a redundancy perhaps. His aspirations, backed by a tremendous drive, are to achieve the higher economic and cultural attainments; and the escalator is to be knowledge derived from the world of science. While being carried to this heavenly utopia, man has developed a faith that science and its resulting technological realities can solve any problem, given sufficient money and time.

Equally dynamic as the affluence explosion caused by science; but yet to be felt, is the effect of freedom realized by the fifty per cent increase in nations over the past decade and one half. Will the rewards of resource productivity and the dissemination of scientific know-how be sufficient to offset the uncontrolled population increases which seem sure to come?

The key questions, therefore, before our nation and the world relate to development of appropriate policies which convert science and technology into meaningful programs, which, when properly designed and executed would optimize the use of our natural resources for the desired higher attainments of man. Such policies could be the connecting links between available knowledge and its realization in practical situations. Therefore, the efforts at research and education should be centered on development policies and planning. Properly researched policy will provide the needed guidelines and directions to meet the projected demands for a nation and world population calculated to double in the next 40 years. [1]

The term policies as used here is intended to include laws, directives, resolutions, or even customs established by tradition and culture. As they exist today they may be placed in three categories:

[1]Hans H. Landsberg, Leonard L. Fischman, and Joseph L. Fisher, *Resources in America's Future*, published for Resources for the Future, Inc., (Baltimore, Johns Hopkins Press, 1963), 1017 pages.

a) policies which serve the public's interest adequately;
b) policies which favor the interests of various groups at the expense of others; and
c) policies which are intended to serve the public's interest, but in fact, are out-of-date and thus impede the way for the emerging philosophies and developing technology.

My proposition, therefore, is that the greatest need today in the natural resources field is to up-date, coordinate, and equalize for all men the various resource development policies. They should be more consistent with each other and in a better harmony with the broad policies relating to growth, foreign trade, defense, and the quality of life.

Satisfactory economic growth has been established as national policy. We would not expect the real costs of natural resources to raise enough to hamper continued growth in the United States,[2] as there is no reason to expect any widespread scarcity of resources or their products before the year 2000 in the United States, excluding circumstances radically different.

According to some outstanding economists, as a country becomes richer, natural resources relative to total resources will decline in contribution to the gross national product.[3]

This finding contradicts the Ricardian concept of diminishing returns and rising prices for raw resources which hasn't held. The fact that it hasn't is due to improved technology and development of substitutes as well as new sources of power. In the modern world we have solved the stream of problems coming out over time. Were we not able to do this, the Ricardian concept would have held.[4] Will we be able to accomodate continually the problem stream as it relates to the natural resources? Economists conclude, further, that the complex process of economic development is sometimes influenced but never decisively swayed by natural resources.[5]

To the conclusion of declining importance of natural resources in economic growth, Mr. Dale makes this plaintive comment. "I confess to believing that good soil resources for food supplies, good coal for hydraulic resources and, if you like it, certain features of

[2]Hans H. Landsberg, *Natural Resources for U. S. Growth*, Published for Resources for the Future, Inc., (Johns Hopkins Press, 1964).

[3]T. W. Shultz, "Connections Between Natural Resources and Economic Growth," page 116. Essay from the collected essays of J. S. Spengler, Editor, *Natural Resources and Economic Growth*. Conference, April, 1960., sponsored jointly by Resources for the Future, Inc. and the Committee on Economic Growth and Social Science Research Council, distributed by Resources for the Future.

[4]Chandler Morris and Harold J. Barnette, "A Theoretical Analysis of Natural Resource Scarcity and Economic Growth Under Strict Parametric Constraints," pages 20-27. This is from the Spengler papers—see footnote 3.

[5]John H. Adler, "Changes in the Role of Resources of Different Stages of Economic Development, pages 48-70. This is from the Spengler papers—see footnote 3.

climate and water supply, are all natural resources of very great importance to economic development." [6]

At this point I would predict, with a high degree of certainty, that a lively discussion could be held about the relative importance of natural resources to economic growth. Probably, once the terms of analysis were defined and understood, the differences arising from different lines of analysis would be unimportant. Too often natural resources are considered as a homogeneous group. To aggregate into one category crops, timber water, fuel, and minerals may be stretching a good thing too far. Thus, clarification and identification of the contribution by various resources should be basic to work done to develop further any newer resource policies.

Seven focal points for attention to resource policy development are now listed.

1. One of the most noticeable phenomena of the past 20 years has been the growing understanding that it is impossible to develop one segment of renewable resources without impinging directly or indirectly upon others. [7] Birds, mammals, fish, plants, grasslands, forests, soil, water, land, and wildlife and their place in the universe are matters of concern within the framework of expanded demands for more hydroelectric power, flood control, irrigation, reclamation, recreation, drainage, navigation, food and fiber production and industrial development. Out of this problem has come the great idea of multi-purpose use and management. How to accomodate needed resources which compete with each other is the problem. Real ingenuity in policy-making and in the management of the policies once developed is called for. Examples of planned multipurpose use are scarce and limited to certain resources. Research needs cry for attention in some of the critical areas of industrial development, mineral mining, and land and water needs.

2. The land, water, air, mineral, and timber resources to be sufficient over the next 40 years planning period will require efficient use to meet the expanding needs. The conceptual models for allocating renewable or non-renewable resources and for policy development in relation to economic growth have been developed. [8] The basic question is the rate of flow of the resources and their products into the channels of consumption. For the non-renewable resources expected to be in short supply, policies should encourage highest priority uses and encourage adequate stubstitutes, while for renew-

[6] J. H. Dale, Comment on Shultz's paper—see footnote 3.
[7] Ira N. Gabrielson, "Needed: A Natural Resources Policy," Chapter 11, pages 181-190, from America's Natural Resources, Edited by Charles H. Callison. (New York, The Ronald Press Company, 1957).
[8] Joe S. Bain, "Resource Policies in Relation to Economic Growth." This is from the Spengler papers—see footnote 3.

able resources, policies must encourage sustained or increased production.

3. Distribution of the costs and benefits of resource development presents more than a casual problem to the researcher. Too often cost and benefit analyses are made first for development of a project proposal, and thus for the purpose of selling the project to the source of funds. Under such circumstances, costs and benefits are usually skewed in favor of adoption of the project and without information on alternative projects. The tendency to leave out the social benefits and costs of external economies and external diseconomies has created tremendous problems which must be solved now. How do we measure and account for the external economic and social effects as well as allocate costs and distribute the benefits properly?

An external factor of increasing importance and increasing concern is that of the environment in which we live and breathe. As the country continues to populate and to industrialize, which has a marked effect upon the quality of life, we are becoming increasingly conscious of the problem of social adjustment to a variety of adverse indirect effects of technological change and economic growth. In contrast to being concerned with the scarcity and allocative problem of natural resource, we are now concerned with the human being, his life, his environment, and his satisfactions. Concern here centers on: pollution of the air and water; pesticides and their effect on wildlife; disfigurement of the hillsides; and beauty and order in the urban areas and in the countryside. These thoughts raise the question whether the decisions in the market place might be guided by or made within the framework of society oriented decisions, which admittedly would introduce value judgments. Is there a better way to forestall some of the adverse effects of technological advance? It seems clear that cost-benefit analysis should include the socio-technical parameters on both sides of the balance sheet.[9] Society can place values on desirable environment, even though they are merely judgments.

4. Shouldn't we be more concerned with the consumption of our resources than we are?[10] Interference with the consumption side is sometimes said to be abridging our basic freedom, but at the same time the gross waste that takes place in the consumption process is something to behold and should not go unnoticed. Can the appetite

[9]H. J. Barnette and Chandler Morris, *Scarcity and Growth: The Economics of Natural Resource Availability*, published for Resources for the Future, Inc. (Baltimore, Johns Hopkins Press, 1963).

[10]J. K. Galbraith, "How Much Should a County Consume?" published in *Prospectives on Conservation: Essays on America's Natural Resources* by Henry Jarrett for Resources for the Future, Inc. (Baltimore, Johns Hopkins Press, 1958), pp. 89-99.

of people be influenced to equate wants more closely with supplies? Can we continue to take the heart out of the melon and discard the rest? Ways of regulating consumption such as altering the price structure, correctly placed subsidies, and allocating more funds to research for the development of substitutes are some alternatives.

5. To what extent should society exercise greater control on man's relationship with himself and with nature? The socio aspects of life, the cultural factors, the patterns of value systems, and the political systems definitely influence the framework of attitudes toward natural resource use and management. With less open space per individual, with greater demand for social and community amenities, social interdependence naturally follows. Thus, more control by society gains in relative importance at the expense of rank individual freedom. Freedom needs to be defined and continually redefined. Where is the breakpoint between individual rights of freedom as a concept of liberty against the responsibility of a society to decide or control. Such a breakpoint would shift through time, and thus our system should be flexible to allow our policies to adjust with the change.

6. Coordination of institutions, agencies, and arrangements is a need of increasing importance as government becomes more important to process, whatever the process may be, with its multiagency system and bureaucratic procedures; with educational institutions becoming involved; and as inter-relationships become more complex. Natural resource policies need to be coordinated with public works policies, taxes, subsidy policies, transportation policies, and foreign trade. Cooperation between agencies and groups is a matter of increasing public activity. The results of regional studies which relate all important factors need recognition in reality. Such coordination, obviously, would require very much work and thought, yet it must come.

Government at all levels, policy-making groups of different types, and business establishments need workable concepts which relate cause and effect of one resource upon another. In short, alternate workable plans are needed which might be adopted in support of natural resource development. The framework of the plans must relate the economic, political, and cultural factors affecting resource management.

In the modern age of computers, information retrieval, and new mathematical models, the complex inter-relationships between the alternative uses to which any given resource can be put may now be examined in the light of priorities, resource combinations, operating procedures, development and management plans, and cooperative arrangements varying in quantities, prices, costs, benefits and productivity. Given studies of this type and complexity, public policy making becomes more realistic to our future needs. Examples might be optimizing the allocation of scarce water supplies of a major river or optimizing an industry contribution such as coal.[11] Indeed, the chasm of needs seems bottomless.

7. If research generates knowledge, and education disseminates it, then education becomes important equal to research in the resource development policies. To be effective, resources polices must be understood by those it will affect. With the great storehouse of information already in supply much greater use should be made of it in textbooks, course offerings, and curricula. Significant progress has been made in conservation education. However, specialized schools and institutions of higher learning, departments of sociology, public administration, economics, and law have not gone far enough in including natural resource courses. Probably this is because more emphasis has been given to the physical relationships than to the social, political, economic and legal. Students in these fields may disagree, but I hold my ground on the merits of relative attention.

Developing regions need to know a great deal about their natural resources, and, as it turns out, they are the least informed about them, and the natural resource base is more important to economic development in the under-developed region than to the developed one.[12]

The essential task of education is to translate knowledge into programs of development, in resource plans, and in functional policies as these translations are the connecting links between the scientist and action. It is in this context that we must put knowledge.

That education could be an inexpensive substitute for a massive public expenditure for structures, *e.g.* water impoundments, is a reasonable hypothesis. Assume as given two large watersheds equal in all respects, including a complete lack of control over the water volume, flow, and quality. In one instance a complete educational program is carried out and in the other only mechanical structures are used. These being the extremes with a graduated scale connecting them, where would lie the point of optimum combination—on the education side or the mechanical side of center? It is doubful if those agencies concerned with the mechanical side or with the

[11]Gilbert F. White, Committee Chairman, *Social and Economic Aspects of Natural Resources.* A report to the committee on Natural Resources of the National Academy of Sciences—Natural Research Council. Publication 1000-G, Washington, D. C., 1962. This report presents a good discussion on systems analysis of resource industries. In addition, the section on NEEDED RESEARCH is quite worthwhile.

[12]T. W. Shultz, op. cit.

educational side are seriously concerned with the complementing side to develop the least cost-most effective relationship between education and mechanical control.

No one knows yet what would happen if a massive education program was carried out on a sustained basis on a large watershed in which a concentration of factual information was effectively taught to the residents and owners in the watershed.

In conclusion, much as been done about resource policy development, but the need for extending and expanding the research and education work is very great. Colleges need to go much further than they have in organizing course offerings and curricula around natural resources development. The unfinished task, when viewed from the pinnacle of expectations for the year 2000 appears horrendously large.

NEW CONCEPTS IN ENVIRONMENTAL PLANNING

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I. INTRODUCTION

The human use of the earth requires many different kinds of land uses: for homes, factories, shops, forests, transportation, mines, ports, parks, water supply, wilderness, and so on. Each one of these uses may be needful and legitimate in its own place. The challenge of the civilized landscape is to get each use in its right place, fulfilling its function without harming any other wise and legitimate use. Often the same land may be used for multiple purposes without conflict.

Land as such may be considered as fixed whereas the dynamic elements of the landscape (air, water, living forms and organisms) are not fixed, but are mobile, migratory, and wandering. Thus our concepts of physical planning which tend to be based on fixed geographic space must be supplemented and augmented by concepts of planning based on movement and mobility. The new concepts of environmental planning, therefore, demand that man-made borders such as city, township, county, state or province, and even national boundary lines, must be considered as non-existent for purposes of environmental planning.

To accomplish environmental planning on a holistic, or even synoptic basis, requires a high degree of statesmanship by elected representatives, an awareness of the total problem by scholar-scientists, and curriculum revision to permit a greater understanding of the man-earth equation by the students in the schools.

Much is already happening to show a definite trend in environmental planning and this paper will delineate briefly these trends in three major categories: regional planning with inter-governmental or multi-governmental involvement, the programs of scientific organizations and professional societies with interdisciplinary attention to complex environmental problems, and certain promising programs in curriculum revision and development wherein is shown an increasing recognition of the environmental factor in earth sciences, life sciences, and regional studies.

II. REGIONAL PLANNING

1. The Great Lakes-St. Lawrence region of Canada and the United States has become the major industrial area of the world. Geography, history, and economics have combined to give this region a prime place in the hierarchy of favored areas as measured in terms of productivity, the returns to invested capital, and the general income levels of its inhabitants. The region is shared by at least two provinces and eight states and involves the federal powers of two national neighbors. Much cooperation has taken place on specific projects, such as the Seaway, but a unitary approach to the entire region is still lacking. Much has been done in research, planning, and development on a fragmentary basis but as yet no focus to the region has been possible. The universities in the region are moving slowly toward a regional approach, but all efforts will be ineffective in the absence of developing cooperation on the parts of the senior governments of the states and provinces as well as the federal governments.

2. The Columbia River Treaty has presented a formal foundation to cooperation in the management of a regional resource on an international basis. The treaty is specific with defined categories of the total resource base but the very fact that individual parts of a complex resource pattern cannot be isolated and separated for long means that the senior governments will be confronted with an ever increasing pressure to deal with a unitary region on a unitary basis despite the existence of national, state, and provincial boundary lines.

3. The New England states of the United States and the Atlantic provinces of Canada face many problems created by a similarity in geographical position, historical evolution, economic development, political growth, and social change. The areas face common and similar developmental problems. Each has learned from the other and an understanding based on the sharing of information has evolved steadily throughout the years. This understanding and shar-

ing will deepen as the problems of the next two decades are faced by the people in the region.

4. The United States has identified by many measures its regions of economic stress. Many journalistic phrases have been invented to describe these areas: slow growth areas, pockets of poverty, the new poor, and so on. Many programs have been and are being worked out to deal with economic stress in its regional definition and dimensions. The program for Appalachia is an example of a policy which although related basically to people and their resources nevertheless has the properties and characteristics of territoriality. The program involves the federal governments, many states, and hundreds of local government units. Canada has a counterpart approach to ascertain which parts of the country have economic and social disadvantages as measured by various criteria related to national norms. When the United States and Canadian maps of economic stress or economic disadvantages are matched and compared, an area of concern to each country appears as a single problem region. This is the Upper Great Lakes area of Northern Minnesota, Wisconsin, Michigan, and northwestern Ontario, an area that has seen many successive waves of heavy exploitation. Such ominous phrases as "cut-over" land and "mined-out" counties have been applied to parts of the Upper Lakes region yet it is through the proper management of forests and mineral lands along with other land and water resources that the region will develop its future on a permanent base. It is altogether likely that a "Cut-over Lands" project will form in the United States and an "Upper Lakes" program will form in Ontario with federal-provincial cooperation. A sharing of information, techniques, program analysis, and operations should be made possible and encouraged between the two countries as a unitary area divided by an international boundary line is studied and developed through different but similar programs.

5. Many far-reaching and large-scale proposals have been suggested and presented to adjust the continental water budget through complicated engineering and water management devices and works. The North American continent has great areas with water deficiencies, both normal deficiencies such as the United States Southwest and man-made deficiencies due to an increasing pressure on existing water resources, such as in certain parts of the Industrial East. One single proposal, the North American Water and Power Alliance, suggests the collection of excess water from the Alaska, Yukon, and other Northwest rivers and through systems of dams, canals, rivers, and pumping stations delivering water to water-short areas of the United States, Mexico, and Canada. The project in-

volves, in addition to the three federal governments, many states and provinces. It is a proposal truly continental in scope and should not be dismissed idly because of its seemingly high price tag or its apparent international and domestic political complications. Proposals such as the NAWAPA must be studied carefully and dealt with as seriously as are problems of space research and national defence. Water is a fugitive resource and is both developable and manageable to a high degree using an existing technology. Furthermore, the control of water is the most available and practical means whereby man can change the face of the earth to improve the habilitation factor. Many other proposals for adjusting regional water budgets have been made for more limited areas and many of these proposals have been acted upon. In Ontario, serious study is being given to a possible expansion of an existing program to adjust the water budget of the Great Lakes. Certainly, it can be said that the management of the water resource is the most available and most meaningful way for man to plan and modify his regional environment.

6. The most immediate and pressing problem facing North America is related to the control of a burgeoning urbanism. Planning, as a definition, may be considered as the steering of the elements of growth and development toward socially desired goals. Inasmuch as North America, in population, is largely urban, environmental planning as it deals with people and where they live should be related very closely to the urban landscape. It is difficult to discern any reasonable attention to environmental planning in our complex urban areas. Urbanism in North America exists larely in two concentrations, the Megalopolis of the Eastern Seaboard and the Grand Trunk Corridor extending from Quebec City through to Chicago. There are numerous small agglomerations of urbanism of the Riviera type in California, Florida, around Puget Sound, as well as outliers of urbanism in Texas, Missouri, and along the Ohio River. North Americans are both the beneficiaries and victims of an agrarian history. Only recently have we realized that most of us live in cities, that the great population increases of the present and immediate future will take place in cities, and that nowhere are our failures in environmental planning more apparent than in the ways we build and maintain our cities. Our expanding cities, which reflect both increasing numbers of people and greatly enlarged living spaces—thanks to the automobile—of the people who live in the cities have sprawled far beyond the original municipal boundaries. The modern North American city is a weird collection of fractional local governments, and a complicated amalgam of conflicting poli-

cies, programs, and accomplishments. It is possible to bring order out of chaos but it is not easy. In many parts of North America, serious studies and programs in regional government of urban areas, mainly admittedly experimental, are underway.

Certainly the challenge of urbanism with the necessity on our part to produce a civilized landscape demands the careful attention of the senior as well as the local levels of government.

III. ORGANIZATIONS

Conferences such as this one reveal through their programs the increasing interest and attention being given problems of environmental planning by scholars and scientists.

In October 1961 the eleven senior governments of Canada, the ten provinces and the Government of Canada, prepared and held a conference on "Resources for Tomorrow." The original plans called for the standard program approach such as water, fish and wildlife, forests, and so on. It was soon found out in the planning stages that the scientists were willing and able to prepare and present papers and monographs of their professional specializations but they were also keenly interested in an opportunity to discuss their skills and contributions with other scientists in the context of the total environment. The program naturally, was broadened and the most significant results of the conference came from the sessions under such program titles as "The urban-centered region" and "River valley development" where earth scientists, life scientists, social scientists, political leaders, and business leaders directed their special skills and common interests to complicated problems of the regional environment.

In February 1965, the Province of Ontario organized and held an International Conference on Regional Development and Economic Change. This type of conference is typical of much that is now taking place at state and provincial levels. A brief listing of the major topics covered by principal papers and discussions is indicative of a present search for understanding: The Development Challenges of our Times; Areas of Economic Stress in Canada; Regional Development in Ontario; United States War on Poverty; Four Case Studies of Regional Development in North America: The Appalachian Region, The Province of Quebec, The Atlantic Provinces, New York State; Four International Case Studies: Sweden, Netherlands, Colombia, United Kingdom; Centralization or Decentralization of Economic Growth?; Shaping the Regional Development Program; The Inter-action between Economic Development and Regional Environment; The Role of Private and Public Investment in Regional Development; Is Regional Government Necessary?; and The Shape of the Future. The Background Papers of the Conference have been published and the Transactions of the Conference are in the press.

One of the purposes of the conference was to encourage the ten regional economic development associations in Ontario to undertake regional conferences of their own. Within a week of the provincial conferences, the Lake Erie Regional Development Association organized and announced its regional conference to be held in April. This demonstrates once again the significant multiplier effects of national, provincial, and state conferences when these conferences are organized with transfer values built right into their structure.

IV. CURRICULUM REVISION AND DEVELOPMENT

Forty percent of the population of the United States, Canada and Mexico are under nineteen years of age. Most of these young people are in schools. The curricula of any community must have mobility and flexibility to change with changing conditions, particularly the changes which have been brought about by the educational process itself. A brief review of the literature of curriculum development indicates clearly that the environmental sciences and studies are being included in the learning stages for the young scholar. Even in the universities with the narrowest specialist traditions, an interdisciplinary or broadening influence is at work. Particularly commendable are the works of many of the professional scientist groups, such as geographers, biologists and geophysicists, which are working intently with curriculum specialists to improve the eclectic understanding of the young scholar regarding the man-earth relationship.

It is altogether possible that the next decade may see rapid progress in the evolution on this continent of what may be called an official plan for environmental betterment. This will not be a formal document with sections and sub-sections, but it will be a generally agreed understanding by all our citizens of the need for, the possibility of, and the rewards from an eclectic and synoptic understanding of man's role as both an agent and an element of the environment.

There is a challenge here to those of us who today occupy the roles of scholar, teacher, scientist. It is for us to encourage those of our fellow scholars and students who are eclectic in their outlook to work at the interdisciplinary level as well as at their own more restrictive professional specialization. It may be difficult to find many with these inclinations, but perhaps not many are needed. The incidence of idea leadership is always thin. Perhaps our scarcest resource in the final analysis will prove to be the small hard core of individuals who have the initiative and leadership to see the environmental problems in total perspective and who are able to act to get the answers to the questions they ask themselves.

CONSERVATION FOR CITY AND COUNTY

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Less than ten blocks from this hall stands a machine of the utmost significance to the American people. It has no launching pad, no intricate system of computers or electrical conduits, no elaborate provisions for security. Yet, for sheer explosive and destructive power, it may ultimately rival the most terrible weapons the world possesses.

I refer to the population clock in the front lobby of the Department of Commerce—and the reminder it provides—a machine whose cylinders record within incredibly few seconds the net increase of births over deaths throughout the United States.

Enough has already been said about the population explosion, and what remains to be done, but I would remind this audience that two-thirds of the nation's population now lives in urban America, and in all but 11 states, half of the population is urban-oriented. A billion acres were classified as farmland by the 1960 national census, but our improved highway systems, increased standards of living, and lengthening leisure opportunities now cast an urban influence on a growing proportion of this country's prime productive land.

It is safe to assume that the nation will pass the two hundred million population mark before the turn of the next decade. If past trends continue, a million acres of rural land will succumb each year to the highways and roof tops of suburbia in the course of this advance.

At the forefront of our present land-use dilemma are the nation's 100,000 local governmental units, of which one in three are at the county, township, or special district level. Their close ties to the land and its people, whose heritage of self-reliance is traditional, make these units allies of great potential significance if their resources and capabilities can be harnessed effectively.

The concept of the county derives from early feudal times in England, whose first governmental units were known as "shires." After the Norman conquest, the French term "conte" was adopted, later anglicized to "county," and brought to this country with the first settlers.

The grouping of individual families into villages and townships is as old as civilization itself and predicated upon the general necessities of safety and convenience. It was not surprising, therefore, that one of the earliest acts of the colonists was the Township Act of 1636, which gave individual towns the authority to manage their own affairs, make and enforce ordinances, choose their own officers, and distribute settlers within their boundaries.

To this very day in New England, the affairs of individual towns are considered at annual "town meetings," at which every resident is free to appear, speak his mind, and cast his vote, much as was the case three hundred years ago.

Since that time, local units of government have flourished wherever the country has been settled. Given proper leadership, good teamwork, and a spirit of citizen determination, this overlooked and unexploited force may well prove critical in the universal struggle against unchecked urban sprawl.

The spark for effective citizen action can occur anywhere.

In California, for example, a dramatic series of articles by the San Francisco *Examiner* in 1955 helped bring about pioneering efforts to protect productive farmland through agricultural zoning.

A voluntary special revenue program backed by Minnesota sportsmen in 1951 became the forerunner of a national movement to save the wetlands.

A trip to Germany and Switzerland in the early 1900's by Harris Reynolds of the Massachusetts Forest & Park Association resulted in the town forest movement which now embraces some 4 million acres in 4000 separate ownerships throughout the country.

The loss of a million tons of topsoil each year in Pennsylvania and Delaware as a result of outdated agricultural practises led to the establishment of a model citizen association in 1946 within the Brandywine Valley and the beginning of a watershed movement which now attracts hundreds of workers annually to each National Watershed Congress.

The fact that determined citizen efforts can figuratively move mountains is amply illustrated by the following examples.

The initial beautification of six miles of highway in 1944 by the New Jersey garden clubs has now brought about a system of "Blue Star Memorial Highways" covering more than 25,000 miles nationally.

New England's Leagues of Women Voters were determined to experience water problems firsthand. A series of "Know Your River Basin" bus tours gave effective meaning to a national study item on water and resulted in united support for an interstate compact on northeastern water and related land resources.

Growing concern for the state's unsolved conservation problems encouraged the League of Ohio Sportsmen to convene an Ohio Conservation Congress in 1948 and set the stage for the establishment of one of the first unified Departments of Natural Resources in the country.

Honolulu's unique Outdoor Circle of civic-minded women took on an entire outdoor advertising industry over a fourteen year period to effectively curb the use of billboards on the islands of Hawaii.

The small town of Danvers, Massachusetts, managed to divert an interstate highway, forestall a 200-unit subdivision, and raise a $300,000 bond issue by two-thirds vote at town meeting just because it felt the open space and historic character of the community was worth saving.

With so imposing a background of citizen accomplishment, of which the examples above are just a few, it was inevitable that the conservation of natural resources should become a formal part of our heritage of community self-reliance. An interesting experiment to this end has begun in Massachusetts and has spread from there to other New England states. Its success to date shows evidence of a promising new tool for the nation as a whole.

This event was assured in 1957 by the passage of a Massachusetts enabling act which now permits any city or town within the Commonwealth to establish a local conservation agency, known as a conservation commission. Similar enabling legislation has been placed on the statute books of Rhode Island, Connecticut and New Hampshire, and, to date, some three hundred local commissions are in existence throughout New England.

Conservation commissions are comprised of unpaid private citizens, appointed for staggered terms of office by the responsible municipal authority. The commission serves as an inventory, planning, policy, and action agency of the community in the natural resource field. By Massachusetts statute, it is also eligible for technical and financial assistance in such areas as recreational planning, or the acquisition of lands for recreation, watershed protection or open space purposes.

A companion program at the county level has been developed in Iowa with the establishment of County Conservation Boards. First authorized by legislative act in 1955, the movement has grown to include 83 counties at the present time, or some four out of every five counties in the state.

Five-member conservation boards are appointed by each County Board of Supervisors, and serve without pay in this capacity. The conservation boards are charged with broad responsibilities in the natural resource field and, acting through the County Boards of Supervisors, with the approval of the State Conservation Commission, may levy an annual tax of not more than one mill on real and personal property to acquire, develop and maintain public parks, preserves and other conservation areas.

A recent study of conservation commissions, conducted by the University of Massachusetts with assistance from the Conservation Foundation, revealed some interesting statistics for Massachusetts.

Local resource agencies have been established in communities which collectively represent more than half the population and land area of the state outside the city of Boston.

Two out of every three individuals now serving on commissions are housewives, professional or commercial workers, business owners or executives—significantly, a spectrum of our modern urban society and not individuals exclusively associated with the land.

The four most pressing objectives reported by commissions included preservation of wetland and wildlife habitat, inclusion of conservation in community master plans, the provision of adequate land for public outdoor recreation, and water pollution abatement.

Funding of conservation activities and projects by the communities has not been a significant problem to date even though some two hundred separate projects costing just under a million dollars have already been undertaken.

The preliminary conclusions of the University study point to a demonstrated flexibility, a freshness of approach, and a spontaneity and imagination in meeting new conservation problems—in short, the reflection of a growing sense of environmental awareness on the part of both citizens and communities.

The impact of the conservation commission movement has been felt at the state level as well. During the past seven years, significant state-wide programs have been enacted in Massachusetts in the fields of forest management, marine resources, public access, parks expansion, pesticide control, wetland protection, and historic sites preservation. It is high tribute to the one thousand active private citizens now enlisted in the commission movement, and the favorable conservation climate they have created, that *not a single state resource proposal* failed of passage during this period

Massachusetts has taken additional steps to solidify its machinery for effective citizen action. In 1963, the state's fifteen county soil and water conservation districts, *at their own request,* secured legislative approval of a transfer from the state Department of Agriculture to the Department of Natural Resources. Now termed simply conservation districts, with responsibilities broadened to include the natural resource field as a whole, these local governmental units make available their unique services to communities as well as individual land owners, thereby providing the means for projects beyond the reach of the individual or his community.

Special mention should be made of the new tools that have been developed by the districts to help meet urban community needs. Of prime significance have been the pioneering efforts of the Soil Conservation Service in developing a system of *urban capability classes,* patterned after those utilized in farm planning.

Soils and engineering studies are undertaken at the request of the community, and a series of maps are developed which define the areas best suited for residential and industrial development, for urban improvements such as school sites and highways, as well as for parks, forests, playgrounds, water impoundments, and agricultural areas. These technical studies insure that community master plans will be based upon the physical capabilities of the land, not just the availability of undeveloped space.

An interesting byproduct of these studies has been their educational impact upon community officials and professional planners. Almost inevitably, the studies have revealed a sizable degree of previous development on lands having substantial and even severe physical limitations for the use in question!

Another result of this venture has been the unprecedented teamwork developing between state and federal resource agencies. Special planning teams of forestry and wildlife professionals, coupled with extension and engineering specialists, are now available to conservation commissions and districts to help develop sound long-range proposals for future land-use and growth. It would be difficult to decide which have benefited the most—the communities or the agencies!

Cooperative projects of this nature have effectively reduced interagency rivalries and helped eliminate the competitive nature of public resource services. Professional technicians, long bound by the particulars of their trade, have been exposed to the broader concepts of land use and resource management and have reacted with understandable enthusiasm to their new responsibilities.

The inevitable conclusion of the foregoing is that our country stands at the brink of an exacting but exciting period in its resource history—one in which the county and community forces may well play a pivotal role.

It is obvious that our modest successes in local civic action must be increased many fold if we are to retain our accustomed environmental attributes during the predicted population levels of the seventies.

Yet, the encouraging accomplishments of the nation's many citizen movements have evidenced a need to substantially retool our present resource technology. The traditional training in physical resource management must better recognize the human element these resources are expected to serve.

Thus, our technicians must be taught to raise crops of values, not just physical resources. We must develop a whole new understanding of people management and abandon the type of introversion that has characterized our component fields for so many years. And our schools and colleges should be encouraged to teach the most exacting science of all—in Edward Bernay's words, the engineering of human consent!

The Massachusetts experience has shown that our new urban public is particularly sensitive and responsive to resource values, and in this sense the future is promising indeed. A quick look at our local governmental machinery would indicate there is help available—*if* it can be adapted and persuaded to meet the need.

I look to this Conference to provide the only element lacking—the experience, the guidance, and the leadership necessary to make this movement a national reality.

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PART II
TECHNICAL SESSIONS

TECHNICAL SESSION

Monday Afternoon—March 8

Chairman: W. MASON LAWRENCE
Deputy Commissioner, New York State Conservation Department, Albany

Discussion Leader: ROBERT W. SCHONING
State Fisheries Director, Oregon Fish Commission, Portland

INLAND, COASTAL, AND MARINE RESOURCES

REMARKS OF THE CHAIRMAN

W. MASON LAWRENCE

I am happy to have the opportunity to participate with you in this afternoon's session.

As you have noted in your program, the North American is celebrating its thirtieth anniversary—a 30 years which has seen the greatest changes that have occurred in a like period of time in our history. I submit that the growth of interest and concern in water and water-related resources, while perhaps not quite so dramatic, has followed the same trend. If you were to review the proceedings of the first several meetings of this Conference, as I did briefly, you would find that the programs of the earlier meetings were generally not organized on a technical session basis but that they did contain papers on water-related resources—papers on fish stocking, stream improvement and marsh management.

By the Seventh Conference, in 1942, there were two sessions on water resources: one on the subject, "Propriety and Results of Fish Stocking" and one on "Marsh Management."

By the time of the Tenth Conference in 1945, these had involved into sessions on "Commercial Fisheries" and "Marshes, Water and Wildlife."

Indicative, I believe, of the increased and broadened interest was the change at the very next Conference to sessions on, "Marine Habitat and Wildlife" and "Fresh Waters, Marshes and Wildlife."

Since the Nineteenth Conference in 1954, the program has contained sessions on, "Wetlands and Inland Water Resources" and "Coastal and Marine Resources."

As you will note from today's program, these two sessions have been joined in one and I am told this was done in order to make a place for another special conference on "Water Related Resources," and, namely on the subject of "Waterfowl."

I believe the history of the programs of this Conference are illustrative of the increased attention being given to water resources. The concern of the last Congress and the present Congress about the water resources is unparalleled in our history. This resulted in the passage, by the last Congress, of the Land and Water Conservation Fund Act, the Water Resources Research Act, and the Commercial Fisheries Research and Development Program Act. I might also mention the early consideration by this Congress of the Water Pollution Bills and the Water Resource Planning Bills.

There has been great public interest in New York in the proposals to establish a $1 billion bond fund to carry out a $1,700,000,000 pollution control program in six years.

From the above, it is evident that our program this afternoon involves not only a very broad field but one of increasingly vital concern to our people.

RADIOISOTOPE TECHNIQUES IN FISHERY RESEARCH

T. R. RICE[1]

Bureau of Commercial Fisheries, Radiobiological Laboratory, Beaufort, N. C.

Many new research possibilities have arisen in the field of fishery biology as radioactive tracers have become available. The high sensitivity of instruments used to measure radioactivity has made possible the application of tracers to problems beyond the range of standard methods. Also, the radioisotopic tracer furnishes a means for quantitative determination of biological substances without quantitative isolation. Radioisotopes afford an extremely useful means for: (1) measuring primary productivity; (2) following cycling of trace metals; (3) tracing movements of pollutants, sediments, organisms, and water; (4) studying the physiology, foods, and feeding of fish and shellfish; and (5) using radiation to modify a species through genetic mutation, eradicate undesirable or noxious species, and cure disease. In addition to knowledge gained from the experimental introduction of tracer amounts of radioisotopes into

[1]Research jointly sponsored by the Atomic Energy Commission.

restricted areas of the aquatic environment, much information on the accumulation of certain radioisotopes by organisms has been obtained from fallout radioactivity. Also, by tracking radioisotopes in nuclear reactor effluents, the cycling of specific radioisotopes can be delineated. An excellent review on the use of radioisotopes in hydrobiology and fish culture was published by Hooper, Podoliak, and Snieszko (1958).

MEASURING PRIMARY PRODUCTIVITY WITH RADIOACTIVE CARBON

A new method for the measurement of primary productivity with carbon 14 became available with the production of radioisotopes (Steemann Nielsen, 1952 and Strickland, 1960). This method is 50 to 100 times as sensitive as the light- and dark-bottle oxygen method and permits rapid, convenient measurements in areas of low primary productivity. Its use also is advantageous in highly productive areas because less time is required for measurements. By this method the rate at which energy is accumulated in the form of organic matter can be calculated from the net mass of carbon fixed per unit of time per unit volume of water.

The basic methodology is relatively simple. Samples of water to be used for measuring productivity are collected from various depths in a nonmetallic container such as a Van Dorn water sampler (Figure 1). The water is siphoned into Pyrex bottles similar to those

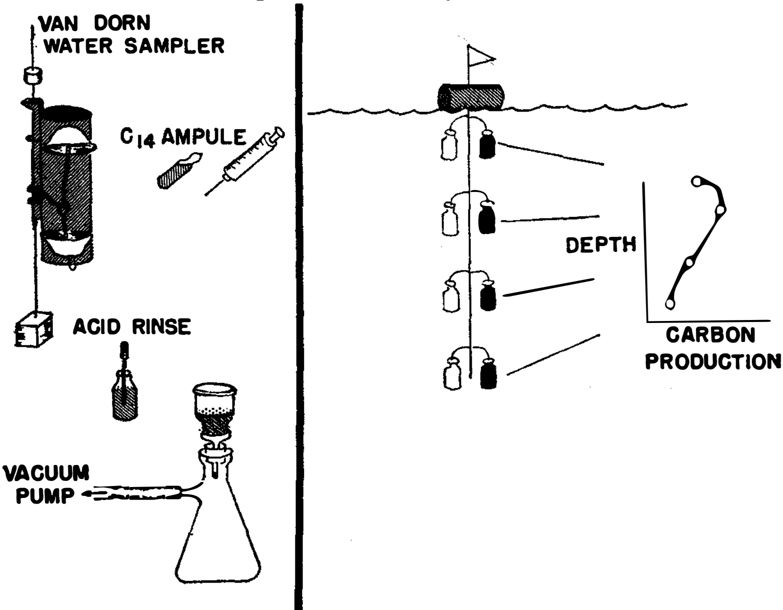


Figure 1. Measuring primary productivity with radioactive carbon

suspended from the buoy. A known amount of carbon 14 as bicarbonate is added to the bottles with a syringe. The uptake of carbon 14 by nonphotosynthetic processes is measured in a second sample, similarly prepared, but kept in a black bottle. The bottles can be suspended in the water at the depths from which the samples were taken or illuminated under standard conditions in the laboratory or on shipboard. After a period of time that usually does not exceed 24 hours, the water is filtered through a fine filter (usually an HA Millipore Filter with a 0.45 μ porosity). The cells retained on the filter are then washed with 10 to 20 ml. of a 0.001 to 0.002 N hydrochloric acid solution in 3.5 percent sodium chloride, to dissolve and remove carbon 14 which may be retained on the filter as an inorganic carbonate. The filter is given a final wash with a neutral electrolyte to remove all acid and is then dried. The amount of carbon 14 on each filter is determined with a counter for measuring radioactivity. From these measurements the carbon 14 fixed at each depth is calculated by subtracting uptake values in the dark bottle from those in the light bottle. Carbon 14 and carbon 12 are fixed in proportion to their concentrations, and the amount of carbon 12 fixed per unit volume can then be found from the following relationship:

$$C^{12}_{F} = \frac{C^{12}_{A}\, C^{14}_{F}}{C^{14}_{A}}$$

C^{12}_{F} = carbon 12 fixed

C^{12}_{A} = carbon 12 available

C^{14}_{F} = carbon 14 fixed

C^{14}_{A} = carbon 14 available

These results plotted for each depth sampled yield a photosynthetic profile. The rate of carbon fixation per unit surface area can be determined from the area under this profile.

FOLLOWING THE CYCLING OF TRACE ELEMENTS WITH RADIOISOTOPES

The cycling of some trace elements which may control productivity can be followed with radioisotopes (Figure 2). The fertility of both fresh and salt water is of interest to fishery biologists, since productivity and production of fish are related to the nutrient content

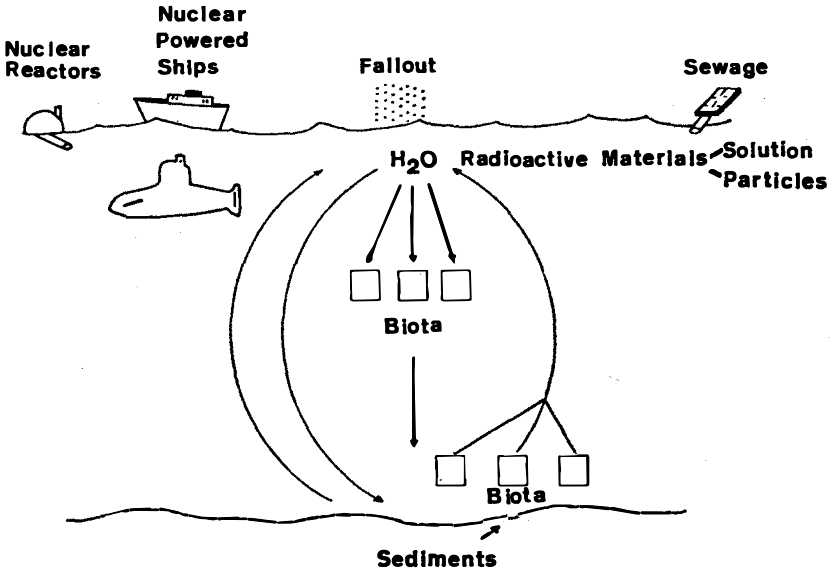


Figure 2. Following the cycling of elements with radioisotopes

of the water. Expectation of increased yields from the application of fertilizer to certain waters has stimulated many biologists to study the feasibility of artificially enriching water with some essential elements. In such instances the addition of radioisotopes to the fertilizer can provide an effective means for following specific elements.

Radioactive materials introduced into an aquatic environment can: (1) remain in solution or in suspension, (2) precipitate and settle on the bottom, or (3) be taken up by plants and animals. Cycling can be expressed as the three R's: routes, rates, and reservoirs. Each element, as well as each radionuclide, follows a characteristic route and has its own rate of movement from component to component or from reservoir to reservoir. Three reservoirs exist in an aquatic environment: water, sediment, and biota. Elements and radioisotopes can move from the water to the sediments or to the biota. In effect, the sediments and biota compete for isotopes in the water.

Pathways and cycling of nutrient chemicals in lakes and ponds have been studied by adding radioactive tracers to the water (Hutchinson and Bowen, 1950; Rigler, 1956; and Hasler, 1957). Similar studies have been carried out in estuaries by members of the staff of our laboratory. Although several different radioisotopes could serve in this type of study, phosphorus 32 has been used most frequently. Characteristics which have contributed to the use of this radioisotope are: its short half-life, making it relatively safe in field experiments; its role as a nutrient element, resulting in its rapid uptake by bacteria and phytoplankton; and its eventual appearance in almost every type of organism present in the water.

TRACING MOVEMENT OF POLLUTANTS, SEDIMENTS, ORGANISMS, AND WATER WITH RADIOISOTOPES

The movement of both animate and inanimate substances can be followed by labeling them with radioisotopes (Figure 3). The dispersion of pollutants in the natural environment has been followed by adding radioisotopes to the substances (Simpson, Beetem, and Ruggles, 1958). Also, radioisotopes have been used to trace the Los Angeles City sewage effluent into Santa Monica Bay (Pearson, 1959).

The capacity of sediments to sorb radionuclides from water can be used in many ways by the investigator. Engineers now label sediments with radioactive gold to determine sedimentation rates, to locate and measure bottom scouring, and to follow sediment transport in bays and estuaries. Labeled sediments can help ecologists follow the "silting in" of bottom fauna and the transport of substrates. With this information the most favorable location for shellfish beds can be determined.

Although sediments are not often included in the food web of marine organisms, some bottom feeders evidently use organic materials in sediments as a source of nourishment. Many organisms, for example the penaeid shrimp of the Gulf of Mexico, periodically move to inshore areas, remain for a short time, then return to offshore waters. It has been suggested that while in the estuary the shrimp feed on the organic matter contained in the sediment. Laboratory experiments in which sediments containing radioactive organic material are fed to shrimp would yield information on the extent to which this sediment-sorbed material is used.

Marking or tagging methods have been used for many years to

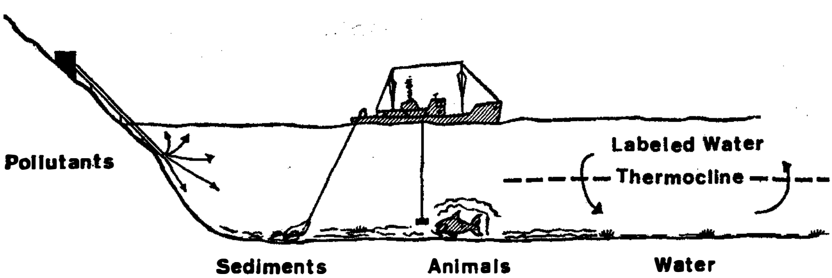


Figure 3. Tracing movement of animals and substances with radioistopes

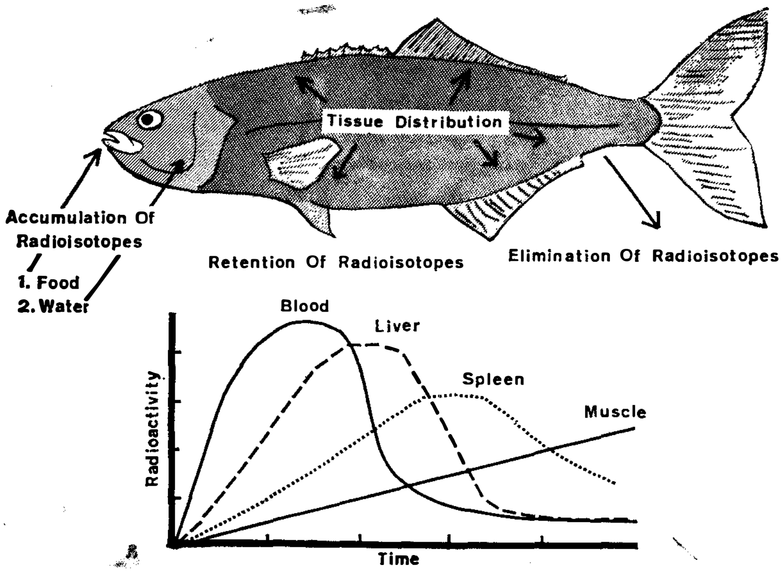
study the movement, migration routes, growth rates, mortality rates, and other aspects of the life history of organisms. Radioisotopes are among the many new methods of tagging fish which have been considered (Seymour, 1958). Recently the Bureau of Commercial Fisheries has tagged herring with an internal magnetic tag in an attempt to develop a radioisotopic tag. To improve the "tagging method" several factors must be considered, such as the ease of applying the tag, its effect upon the animal, its permanency, the ease of detecting the tag for recovery, and the cost of tagging and recovery. To be suitable for use as a tag, a radioisotope should be a gamma emitter with a high energy and a long physical half-life. If used as a tag in a tissue, it should be concentrated to high levels and have a long biological half-life. Much more research with several different types of animals is needed before it can be stated whether radioisotopes have certain advantages over other tags.

Nuclear detonations in the Pacific afforded the first opportunity to trace water masses contaminated with radioactive materials. The technique of following water movement by adding a radioisotope has been used frequently since that time. The advantage of a radioisotope is that even the small quantities that remain after tremendous dilution can be measured accurately. Vertical mixing, direction and rate of water movement, and possibly flushing rates in estuaries can be followed with radioisotopes.

STUDY OF THE PHYSIOLOGY, FOODS, AND FEEDING OF FISH AND SHELLFISH WITH RADIOISOTOPES

Radioisotopes afford an extremely valuable means for following the absorption and transport of materials in marine organisms and for elucidating metabolic reactions and transfer rates (Figure 4). Even though it was recognized that many body constituents of fish were continually undergoing simultaneous formation and degradation, it was difficult to demonstrate this action before radioistopes became available (Baptist and Price, 1962). For example, exchange now can be measured by the transfer of radioactive atoms even when there is no net chemical change. Radioisotopes of elements in biological systems, such as hydrogen, carbon, and phosphorus have found increasing application as "tracers." Their use in the identification of intermediate compounds and the qualitative description of biochemical pathways and reaction mechanisms has resulted in unprecedented advances. Further, studies of transfer and turnover rates of substances in living systems now can be carried out with radioisotopes.

Radioisotopes also may be used advantageously to obtain answers



Tissue Distribution With Time After Intake Of Radioisotopes

Figure 4. Studying the physiology of fish with radioisotopes

to some of the problems in the study of foods and filter feeding of primary consumers (Figure 5). Before radioisotopes became available it was difficult to compare the suitability of different species of phytoplankton as food for the clam, *Mercenaria mercenaria* (Rice and Smith, 1958). To make such a comparison without radioisotopes required that one species of phytoplankton be fed to a clam at a time. It was assumed that the clam always would feed at the same rate under identical conditions. In our laboratory we found, however, that the same clam did not always filter cells of a species from the water at the same rate, even though the concentration of cells and other factors were duplicated. Consequently, meaningful comparisons could not be made between different species of phytoplankton fed to the clam at different times.

It was found that the suitability of two species of phytoplankton could be compared if they were labeled with different radioisotopes and fed to the clam at the same time. The filtering rate for each species could be followed simultaneously. One species of phytoplankton was labeled with phosphorus 32 and the other with calcium 45 (Smith, 1958). The radioactivity of each of these isotopes could be determined in the presence of the other. After growing

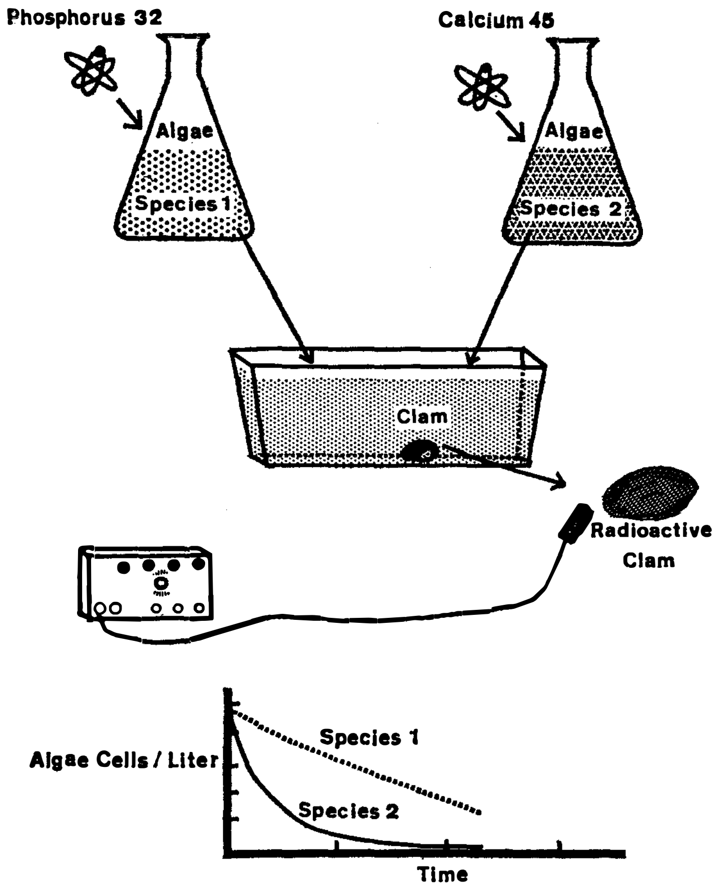


Figure 5. Determining filtering rates of clams with radioactive phytoplankon

cells in medium with radioactivity for several days, the amount of phosphorus 32 per cell of one species and calcium 45 per cell of the other species was determined. The cells from the two cultures then were mixed in sea water, a clam was placed in the water, and the rate of filtering was determined for each species. It was shown that the clam can remove phytoplankton cells of different species at different rates. Selectivity is based on the size and chemical characteristics of the cells.

THE USE OF RADIATION FROM RADIOISOTOPES

Man has been confronted continually with the problem of introducing animals to new regions or of replacing a declining stock with a more resistant species. In recent years two outbreaks of disease caused by the microorganisms *Dermocystidium marinum* and MSX have greatly reduced the population of oysters along the Atlantic Coast. In relation to these problems and others, much thought has been given to the possibility of developing more resistant strains, as is done in the breeding of farm animals.

The field of radiation genetics has grown rapidly since 1927, when Müller discovered that the rate of mutation can be increased in the fruit fly by X-ray irradiation. At our laboratory we are determining effects of radiation on marine organisms (Figure 6). Radiation can affect not only the organism being irradiated, but also the progeny of the organism, by genetic mutation. Not all mutations are necessarily detrimental. Increasing the mutation rates in plants by irradiation has enabled plant geneticists to produce more desirable strains of corn, wheat, and various flowering plants. Thus, it is conceivable that irradiation and selection may be applied to the breeding of marine organisms, to develop new strains that can successfully withstand the rigors of a changing environment. The new strains may enable us to produce fishery products in greater quantity or of better quality.

Irradiation also can be used to eradicate certain undesirable or noxious species and possibly to cure disease. The classical example of such an eradication is the elimination of the screwworm fly in the southeastern United States. This pest was eradicated in less than 2 years over an area of 70,000 square miles by weekly releases of male screwworm flies that had been sterilized by irradiation with cobalt

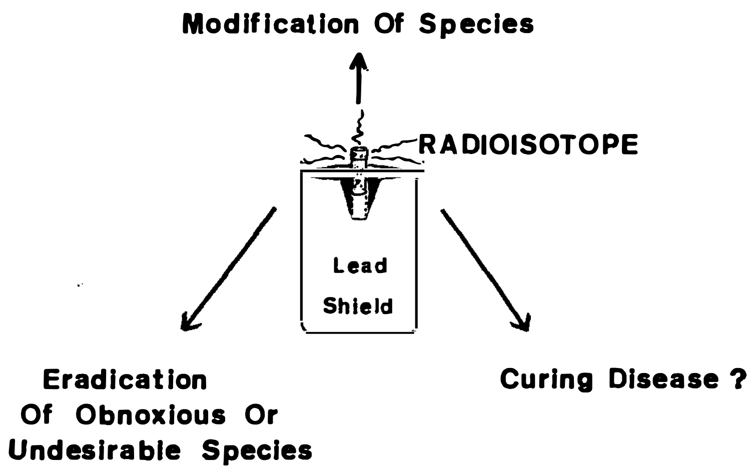


Figure 6. Utilizing radiation from radioisotopes

60. Although this method of eradication has not been particularly successful with marine species in a few preliminary attempts, the accumulation of more knowledge on the effects of radiation on marine organisms will improve the likelihood of success in the future. Radioisotopes have been used on a large scale by the medical profession during recent years to cure disease. A number of observations also have been made of the effects of radioisotopes or aquatic organisms. Iodine 131 destroyed the diffuse thyroid tissue of the Atlantic salmon (LaRoche and Leblond, 1954). Although this was a physiological study, it suggested the need to investigate the possibility of curing certain diseases of aquatic organisms with radioisotopes.

CONCLUSION

I hope you have not been led to believe that I am of the opinion that all fishery problems can be solved with radioisotopes. It is my firm conviction, however, that many unsolved fishery problems will yield to radioisotopic techniques. It is my further prediction that radioisotopes will become increasingly important in fishery research in the future.

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DISCUSSION

MR. GEORGE EICHER (Portland, Oregon): I would like to know if anyone who so desired can purchase or make use of radioactive materials?

DR. T. R. RICE: Not necessarily. Anyone who uses radioactive materials must obtain a license from the Atomic Energy Commission. To obtain this license you must show the Commission that you have training in the use of radioiostopes and that your laboratory facilities are adequate for this usage. However, outside of this, it is possible to purchase certain small quantities of C-14 and some other materials without going through the Commission for it.

DR. TONY PETERLE (Ohio State University): What problems do you encounter using double isotopes—two different isotopes in individual organisms in terms of biological change? In other words, what are the problems connected with double labels?

DR. RICE: Thus far we have not run into any problems. When two radioisotopes are present in an organism neither isotope affects the metabolism of the other under experimental conditions. If the total amount of activity is not sufficient to injure the animal, then there should be no complications from having two isotopes present in an animal at one time.

MR. GEORGE SPRECHER (Wisconsin): I would like to ask Dr. Rice how he disposes of his radioactive animals.

DR. RICE: As specified in the license, we not only have permission to use them but authority to dispose of our radioactive material in the ocean, at a specified place. We must dispose of this material first by dicing the animals, and dissolving their tissues through the use of acids. As a result, once they are added to the sea water, they are dissipated to an infinitesimal quantity so that they can have no subsequent effects upon sea food or man.

VICE CHAIRMAN SCHONING: Ted, you have presented some interesting and stimulating information for the thinking of the audience, as indicated by some of the questions they have answered.

PROBLEMS AND PROGRESS IN STREAM PRESERVATION

HAROLD E. ALEXANDER
Arkansas Game and Fish Commission, Little Rock

Today, as is evidenced by this meeting, there is a growing concern for the physical, cultural and spiritual resources in this country. We have many problems in the use of resources, but none more critical than those concerned with water, and none more acute than preservation of the scenic, recreational, cultural and historic values of the rivers, streams, and marshes which remain unfettered and undredged.

Our problems derive from the impact of more and more people, of technological skills which enable us to change the very face of the earth, and a materialistic philosophy measuring progress only with a "fiscal yardstick," which Nace (1961) has commented, "could lead us into a cultural desert."

In the U.S., we have channeled, dammed, polluted, dredged, straightened, silted and altered our waterways and their environs so completely and profoundly, that our forefathers who once crossed them in their westward migrations would no longer recognize the rivers to which they gave names, depicting their beauty and history, and beside which they built their homes, reared their families and structured the concept of a great and free society.

It has been said that America built its mettle in the wilderness and in "the swift rapids of its rivers" (Broome, 1964). But now, the beauty and history of our waterways are being sacrificed without restraint or restriction, to developments which recognize only our technological competence; and to limited purposes which, even now, are often obsolete in our rapidly changing society. Today, we are in the midst of a struggle to preserve even a few of our rivers and streams for purposes which include the preservation of beauty and diversity in the world around us; and the opportunity to know the character of the land in which was nurtured the culture of our forefathers.

In the industrial East, many rivers reek with pollution and there is little concern for other values beyond the disposal and dilution of human wastes. In the West the rivers run dry to provide water for crops that are often surplus; and swift, beautiful mountain streams are covered by water behind dams built for power and flood control which sometimes obliterate homes, cover land and magnificent scenery in the valleys, and destroy salmon runs; while in the lowlands, draglines gouge ditches, destroying the habitat for wildlife which gives variety and recreation in our world, and effecting drastic changes in the hydrology and biology of the waters. At the present time, the opportunities for preserving the beauty, uniqueness and recreational significance of even a few of our rivers are diminished each day.

We are fully aware that development of land and water resources in this country is essential to produce material benefits. We do contend that material wealth is not the sum total of our existence, and that the "fiscal yardstick" cannot measure all of our needs and desires. Having enough material things alone does not provide a satisfactory life for most people. The quality of our existence includes the diversity and preservation of beauty, and a total emphasis on the use of water to produce power, dilute sewage, or provide navigation does not recognize these needs. The escape from the pressures of civilized living, or for a return to segments of a world which nurtured the spiritual thoughts and aspirations of our ancestors are "among our esthetic and cultural determinants"; they provide unique types of recreation not furnished by man-made developments. The need for preserving "unspoilt nature," of which natural streams are a part, is related to the satisfaction of our spiritual needs.

It is significant that we must continue to take positive action if we are to save our open spaces, wild lands and natural streams and rivers before they are all sacrificed on the altar of our technology.

WHAT HAS BEEN DONE

In 1959, I conducted a survey of stream preservation problems. In the course of gathering information, I contacted a national Conservation Agency. In reply to a question regarding actions that had been taken to preserve streams, a spokesman replied, "I know of no organized effort to protect clearwater streams. I am not familiar with any effort to promote, on a wide scale, the preservation of natural streams and stream conditions" (Poole, 1959). In reference to this problem, (Alexander, 1960), it was noted that, "Thirty-three government agencies, each operating within the realm of limited objectives and authority, are concerned with the management of water" (Miller, 1958). In the course of this initial survey, all states in the contiguous United States were contacted relative to attitudes and actions taken to preserve streams. It was significant that forty-five of these states replied, and nearly all of them (42) expressed great concern over the loss of high-quality streams which had or were providing fishing, recreation and enjoyment of particular types to numbers of people in their respective states. These states listed a total of 148 streams which were recognized as having high "esthetic and scenic values," and 37 listed streams that had lost recreational and intangible values. One state commented that there were "plans for every bit of flowing water." All but two states agreed that there was an "acute need for positive programs" to save streams; while only seventeen indicated any official actions had been taken. It was noted that there was a great apathy among state agencies and national organizations, and there were many positive suggestions on actions that should be taken. These included zoning, legislative actions, coordination of efforts, revised systems of evaluation, a system of national rivers, meaningful research, and as a primary consideration, establishment of a "Board of Review" for water projects. Most states expressed great concern and felt that positive actions were long overdue. But it was obvious that little of a positive nature had been done to provide solutions to this problem.

Since that time (1960) and the present, there have been some changes in attitudes and positive actions to preserve both streams and other resources and an increasing recognition that our habitat is rapidly being altered to produce what Marcuse (1963) has called "a union of growing productivity and growing destruction." This awareness of the impact of bombs and bulldozers, of superhighways, urbanization, of litter and ugliness, of drainage ditches and the unforeseen effects of water manipulations of many types, has led us to question whether we are running the forces of technology or they are running us. Many of us, in looking back, are concerned when we see that the creek swimming hole, the marsh where we shot our first duck, or the coverts where brown quail covied have been lost. Recent actions suggesting that our attitude is changing are shown by the increasing concern over the preservation of such things as wilderness, scenic areas, parks, and space. During the past five years, there have been the following accomplishments:

1. Statements of concern over the loss of wetlands and unaltered streams in the "Hearings Before the Select Senate Committees on National Water Resources, 1960."

2. Publication of the Outdoor Recreation Resources Review Committee Report, "Outdoor Recreation for America."

3. The enactment of the Wilderness Bill, Land and Water Conservation Fund Bill, bills to protect wetlands, The Water Resources Research Act of 1963, the Bill for the "Coordination of Federal-State Programs for Outdoor Recreation," and more recently, bills authorizing twenty new additions to the National Park System and proposals for twenty additional parks, monuments, historic and recreational areas. Among those concerned with the preservation of streams are the "Ozark National Riverways," and proposals for preservation of the Allagash, Buffalo, and upper-Missouri rivers. Recently, 272,000 acres were added to the "no-cut" or wilderness zone in the Minnesota Boundary Canoe area.

One of the most important actions to save natural waters was Senate Document 97, which provided "policies, standards, and procedures. . . for the use of water and related land resources" (1962), which established policies for preserving "open space, green space, wild areas of rivers, lakes, beaches, mountains and related land areas (and) . . . areas of unique natural beauty, historical and scientific interest . . . for the inspiration, enjoyment and education of the people." Among the first positive actions to preserve natural streams on a national basis, was the initiation of the "Wild Rivers Survey," carried out by the Bureau of Outdoor Recreation and other federal agencies. Initially, 64 rivers were selected for consideration and segments of twelve of these were surveyed. These included the Flathead, Skagit, Rogue, Kalamath, Rio Grande, Upper Green, Niobrara, St. Croix, and Namekagan, north branch of the Susquehanna, the Hudson, south fork of the Cumberland, and headwaters of the Savannah. Legislation on wild rivers is being formulated for Congress.

It is significant, however, that these surveys do not make certain the preservation of these or other rivers. There are extensive plans for impounding the headwaters of the Savannah, and others of these streams; and battles are under way to prevent the construction of a power plant on the Hudson—a great river of beauty and historical significance. There are plans for the Salmon and Clearwater Rivers, among the last spawning grounds for the Pacific salmon. Out of the vast plans for water development, other battles brew. For the last remaining 180-mile segment of the 2,400 miles-long Missouri, where Lewis and Clark camped, there are eleven engineering plans for development. (Anon, 1963); in Tennessee, T. V. A. plans to dam the last segment of the Little Tennessee River are opposed by state agencies and citizens groups; and in the Southeast, there has been concern over the ramifying effects of the watershed development program, which had plans for channeling 2,684 miles of streams by 1962. It may be noted that this concern has resulted in a better understanding among the agencies involved. Impoundment prospects for the future are indicated by the combined increase in Corps and Reclamation Bureau appropriations from $812 million in 1950 to $1,343,348,-800 (est.) in 1963, and the present appropriation of an estimated $1,518,000,000 of federal funds for the water resources development in 1965. (Budget Bureau data)

There are on the boards plans for completion of 700 major reservoirs by the year 2000, plus thousands of others of lesser size. They will add up to a very large water bill for the American people (Conservation News, 1962). And among the prize development schemes planned for the future is Rampart Dam, which would destroy forever over 10,000 square mlies of waterfowl nesting and game range, and stop the salmon runs. In its justification somebody has commented, "It would be larger than anything the Russians have built."

ECONOMICS

In this report our major concern is not economics, but the kind of world we and our children may have in the future. However, we are concerned about our potential "water bill," and the systems of analysis which justify developments. These have been questioned by many economists. *Nation's Business* (1963), commenting on the proposed Trotter Shoals dam (Savannah River) states that counties adjacent to Hartwell Reservoir are depressed, and that "most timber land (adjacent existing reservoirs) is flooded . . . (and) the average per capita income is among the lowest in the State." Macinko (1963) pointed out that irrigation payments anticipated from the

Grande Coulee project (Columbia River) offset 28% of the irrigation costs in 1944, and only 10% of costs in 1963. Less than one-half of planned acreage was under cultivation after a decade. Kollmorgan (1953) notes that, "There is an urgent need for alternative plans dealing with flood problems" and refers to "flood plain cannibalism" which will result from permanently covering 150,000 to 200,000 acres of the best lands in eastern Kansas by dams built for flood control.

Other economists suggest a "National policy for irreplaceable values" and a point system to score such values.

Fox (1960) states ". . . an affluent urban industrial society will place less weight upon monetary values and more upon intangible values. . ." It is generally conceded that intangible and recreational values are determined by arbitrary and inadequate systems of analysis in terms of today's needs and those of the future, and that the restricted purposes of management agencies preclude any proper analysis of needs and benefits. In this report, however, we can only touch on these economic considerations.

PROGRESS AND PROBLEMS

In an effort to evaluate the stream losses and preservation actions in the states since 1960, a revised questionnaire was submitted to those states (45) which furnished answers to questions in 1959; forty states replied. Some, particularly those in eastern and western states where recreational values are highly significant, furnished detailed answers. Some states did not reply to specific questions, accounting for discrepancies in total replies tabulated. It was evident there was a great concern over the continued loss of streams, and a complete awareness that positive actions must be taken if unaltered rivers were to be saved for their recreational and other values.

Relative to losses of streams which were listed as having exceptional values in 1959, twenty-two states indicated they had lost one or more of these streams. Utah listed six rivers for which developments had been planned or initiated. In Arkansas, projects to impound the last remaining mountain streams (4) in the Ouachita Mountains were gotten under way, and other dams elsewhere were under construction.

States were questioned regarding the need for adding more rivers to lists submitted in 1960. Some states (19) stated they would make no changes, while others (17) supplied lists not included in 1959. Georgia listed ten rivers; much-dammed Tennessee expressed great concern over the Buffalo, Little Tennessee, south fork of Cumberland and Hatchie. Michigan stated, "We would add another thirty streams."

In response to a question regarding the increase in numbers of impoundments planned or constructed over the past four years, the State of California listed 100 major dams planned, in progress, or constructed over the past five years, and Pennsylvania listed 100 (size unspecified). Kentucky listed thirty, while Montana listed seven dams, two of which are on rivers included in the National Wild Rivers Survey (the Flathead and upper Missouri). One state, Maryland, said, "many," and New Hampshire stated, "in excess of 50." Of 38 states replying, 30 stated plans for or construction of new impoundments were under way. (Inclusion of varied types of impoundments in certain states made analysis difficult.) One state, Tennessee, observed that drainage channels were responsible for large depositions of silt in Reelfoot Lake, and others referred to siltation in lakes and streams.

States were questioned regarding the increase in recreational uses of streams, in ratio to reserviors. Fourteen states indicated use of streams was increasing, while twenty said no. Some stated that uses of both had increased, and others noted changes in "type of use." One state observed that the quality of streams was decreasing due to impoundments; Minnesota observed that stream use by canoeists was increasing rapidly.

Regarding actions taken to save streams, numerous citizen groups were listed which had opposed stream alterations. These included Audubon Society, Trout Unlimited, county and parish officials (Louisiana), Sierra Club, Wildlife Federation, recreation groups, Ozark Society, Wilderness Associations (Montana), Garden Clubs, Chambers of Commerce, and other societies too numerous to list. Some states had opposed specific dams in accordance with federal agencies reports.

In reference to actions taken, both the Wisconsin agency and citizens groups have actively participated in opposing dams on high-quality streams in that state, and the Conservation Commission has established a policy on the "protection and use" of water. They have applied their water (riparian) rights laws to protect streams and other water resources. A bill is being formulated which would provide state legislation for preservation of wild rivers in Wisconsin through application of the principles of water laws which are now in effect. Scott (1964) has stated " . . . there are some wild river values in all waterways, and we should not be willing to give up such values without an effort while fighting to save a few." He noted that success depended on public understanding of the need for preservation of all public waters. He cites the need for a complete wild rivers policy, and recognition of esthetic value.

States were asked if there were problems in stream preservation which did not exist in 1960. Thirty-one states list problems, but qualified their remarks by saying their problems were "basically the same only more so." Nine states said no or gave no answer. Problems listed included pollution, dams, watershed developments, highway construction, thermal pollution, shoreline developments, pesticides, industrial developments, silt, and "government spending programs." Problems vary regionally in relation to human populations, traditional systems of development, and the sums of money appropriated for developments.

States were asked if existing and planned impoundments would furnish sufficient or overabundant waters of this type. Twenty-six states answered yes to this question and nine no. Five states gave qualified answers, noting abundance of impoundments in some areas as opposed to others. Coastal states noted that bays and oceans gave abundant "flat" waters. Some said that boating and other recreation was "crowding out" the fisherman. Again, much concern was expressed over stream losses and several commented that the value of free-flowing streams should not be overlooked, since they become more important in ratio to the numbers lost.

Regarding recreational use of older impoundments, thirteen states said it had declined, and twenty said it had not; the rest qualified their answers, but most indicated that use of older impoundments remained the same or had increased due to "changes in type of recreation," with emphasis on boating and water skiing. Several stated that fishing had declined. Generally, increases in use excluded fishing, and were more apparent where there are rapidly increasing human populations.

Ten states replied that pollution, dredging, fresh and salt water intrusions, silting, and "civilization" were affecting estuaries and their biological and recreational potentials and uses. Since estuaries lie at the ends of river systems, they are affected by any changes occurring in the entire drainage area.

Regarding the effects of watershed developments, which at this time involve 3,863 applied for, authorized and approved projects covering 262,091,100 acres in the U.S., there were many expressions of concern from respondents. Thirteen states replied that their streams were being damaged by developments, and fifteen replied no. Others qualified their answers. States in the Southeast were particularly concerned, and their answers involved such statements as "P.L. 556 has not helped any stream," "loss of fish habitat on small streams," "losing 120 miles of trout water on one stream," and "400 miles of warm water streams to channelization," "projects . . . cause loss on high quality streams." Other states replied that they had been able to work out mitigation plans for some streams, while others had not been damaged.

States were asked whether official or other programs to preserve streams were adequate in terms of future needs. Only five states replied that programs were adequate. Most replied that efforts were far short of needs, and one stated that preservation was dependent on "carrying through" plans. One state referred to lack of personnel for work on these problems, stating it "will be hard put to save a reasonable remnant of its freeflowing streams," and another; "The never-ending obstacle of comparing esthetic values or a few thousand dollars fishery values against a multimillion dollar construction program," and another: "We need higher recognition . . . of fishing and other recreational values." At least two states are formulating laws to protect free-flowing streams. Obviously, few positive actions have been taken in relation to the needs, and systems of evaluation are often influenced by a multimillion dollar construction budget.

In the answer to questions it was apparent that the states were much concerned, but were frustrated and baffled by the complexities of the problem. Several states made very extensive replies and expressed the views that positive actions to save streams were long overdue. It was conceded that criteria for assigning positive values to natural streams were inadequate when compared with the "benefits" that could be calculated from developments for economic reasons, even though these were not and should not be the sole determinant in assessing values significant to society. States suggested "impartial" committees for determining alternative values, "to prevent dispoilation for private gain," another: "we need truly comprehensive planning, so that adequate consideration is given to fish and wildlife, wilderness and esthetic values"; another: "state laws must be changed"; another (Tennessee) commented on the necessity of state conservation agencies expressing their views on wetlands losses and other problems. This state has taken a positive stand on three remaining streams but indicated a large (Corps) dam was planned on one of its rivers included in the national wild rivers survey; another: "mandatory action to require appropriate action on P.L.556 is needed"; another: "we need greater political and public support," and "public apathy will prevent preservation until too late." This last statement expressed the frustration many respondents felt in trying to recommend actions to preserve some of their streams for recreational, esthetic, scenic, and other social values. They have neither the means, the personnel nor the public support needed to combat the army of planners and political forces which align behind the multimillion-dollar sums appropriated to build dams and other water developments.

Of the states contacted, it may be that Wisconsin has the most positive program to preserve some of its fine streams. They have prepared positive conservation policies, explored legal avenues, conducted surveys, and encourage public groups in efforts to establish a state system of wild rivers. Vermont, Montana, Missouri, Pennsylvania and California, among others, have conducted extensive surveys and produced fine bulletins concerned with recreational values of streams, pointing out the damaging effects of developments. Other states and citizens have taken positive action. It is evident, however, that the efforts to save streams are insufficient in terms of the extensive plans to "manage every drop of flowing water."

SUMMARY AND CONCLUSIONS

In summary, I think we can say that there are no new problems, only greatly magnified old ones. There is, I believe, a new awareness that what we may refer to as opportunities for recreation are rapidly diminishing, and that actions must be taken to preserve such opportunities. Recent legislation for the preservation of these things and the National Wild Rivers Survey bear out this conclusion. Through the wild rivers survey we have recognized a principle and taken positive action. I believe, however, that there is a realization that this is not enough; that states and the citizenry need to recognize and involve themselves in these matters, if other than isolated and scattered remnants of streams are to be preserved.

There is also a concern for the inadequate system of appraising the values things have for us. Udall (1962) commented, "Social values must be equated with economic values. The over-riding need of man for an environment that will renew the human spirit and sustain unborn generations requires some sacrifices of short term profits." Clawson and Fox (1961) said, "The basis for decision making is too limited for the kinds of decisions now in prospect."

In making recommendations on courses of action needed to preserve wild rivers, the states reiterated many of the views they expressed in 1960. They called attention to "apathy" and lack of concern on the part of the public, failure of states to make plans in their own interests, the failure of the Bureaus to consider values outside the scope of their limited jurisdictions, the failure to consider alternatives in planning the uses of land and water resources; suggested revised systems of cost-benefit analysis which would provide sufficient consideration of scenic, recreational and other intangible values of recognized social significance; and emphasized the acute need for more trained personnel to gather data to substantiate the worth of fish, wildlife, recreation and intangible values. The lack of research to evaluate short and long term effects of dams and drainage on the hydrology and ecology of waters was pointed out. In this connection, it can be noted that in hearings pursuant to the Bill to establish Water Research Centers in the United States, passed in 1964, there was no mention of research to evaluate the significance or value of recreational uses of water even though this is now a primary and increasing use in this country. The establishment of an impartial Board of Review is a basic need. An oft-repeated view is that planning and construction should be delegated to separate agencies. Federal agencies engaged in both activities tend to favor structural alternatives, even though such things as flood plain zoning may produce greater and longer-term benefits (Fox and Herfindahl, 1962).

The validity of economic criteria used to justify developments is being questioned by many economists. Of particular significance, I think, are views expressed by Fox (1961), in which he points out that traditional objectives in water management which were the creation of navigation facilities to regulate rail charges, public power facilities to regulate utility rates, and full regulation of streams to bring all land into production, are no longer adequate concepts in terms of present problems and future needs. Nace (1961) observed, "The basic trouble is that traditional concepts of land and water development are naive in relation to the complex nature of land and water problems in a mature society."

In the final analysis, we have two essential considerations: the perpetuation of both quality and diversity in the world of the future. As Sears (1961) has noted " . . . once existence is assured its quality . . . is the chief preoccupation of the majority of mankind." We need diversity not only to provide kilowatts of power but also wild rivers, scenery, and opportunities for escape from civilization.

The wild river's survey is a step in the right direction; however, it will not be sufficient to accomplish what needs to be done. Accomplishing this will necessitate concern with this problem by states and citizens groups, and education of the public.

In closing I would observe that a stream is a living thing. It moves, dances and shimmers in the sun. It furnishes opportunities for enjoyment and its beauty moves men's souls: Like the condor, the whooping crane and the wolf, the streams of America are on the road to oblivion, to produce crops we don't need, to perpetuate outdated concepts, and to flow past turbines, which may well become examples of obsolete policies and plans. It is time we gave more attention to saving these living streams which are part of our history and heritage, and which, once they are gone, must see "another heaven and another earth come to pass before they can be again." (Matthiessen, 1961)

DISCUSSION

MR. HAROLD WILLIS (Chairman, Commission of Game and Fisheries, State of Virginia): We are right now up against a fight that is exactly the same thing that the speaker brought to our attention.

My first question is: Is there any way to stop the Corps of Engineers, once they get started?

The point here is that we in the Virginia Game Commission did not quite get started in this thing soon enough. However, we now have the backing of a whole bunch of politicians and Congressmen and in one way or another and even the President has gotten behind us.

Nevertheless, I believe, in the final analysis, that you have to nip many of these things in the bud if you are going to do anything with them because, as you know, once they gain momentum, you are lost. In other words, the forces of conservation just cannot talk loud and long enough.

MR. ALEXANDER: I want to comment on that statement to this extent—that many of these states are concerned with this problem and all of them felt that the states themselves needed to take action and to become involved in these things.

Another major problem in this, I think, is that we have limited criteria for esthetic and scenic values, and we have no valid economic criteria by which, within the systems of analysis, we can determine those values. This is a major problem. We cannot point to a system of evaluation. There are, of course, many states wherein we have arbitrary values that have been set up, but then, in the final analysis, they do not adequately consider the problem at all.

Another major problem in this respect, at least in many of the states, has to do with the lack of personnel. I would like to refer to a statement when we were discussing this in my family during the course of the year, when one of my younger daughters said, "There are too many decision makers around here." I asked, "What do you mean?" She replied, "Well, everybody here is bigger than me." At any rate, this illustrates the kind of situation we are in.

MR. KIRK STRAWN (University of Arkansas): What points have you stressed as major needs of the states?

MR ALEXANDER: I think one of the main concerns of the states is the lack of personnel. The second may be called the application of the fiscal yardstick and the lack of criteria to determine the value of a stream as opposed to impoundments.

Another has to do with the changing needs. They brought up time and again the fact that our lakes are being converted into water skiing areas. Many of them also mentioned the lack of research, and adequate data on changes or effects on the biology of waters.

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FIFTY-SEVEN SPECIES OF FISH IN OIL-REFINERY WASTE BIOASSAY[1]

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INTRODUCTION

A study of fish as test animals for toxicity bioassay in petroleum refinery effluent was conducted from February, 1960 to June 30, 1963, at Oklahoma State University under support of that University and a grant, WP-00067 (C2), from the United States Departmentof Health, Education, and Welfare. Rankings of 57 species of fish are presented. Four papers(1)(2)(3)(4) each presenting a share of the species measured, two papers(5)(6) dealing with oxygen requirements, and one (7) concerning temperature responses resulted from the study.

The publications explain the study, purposes, a history of bioassay procedures, the methods used, the conditions involved, where the fish were obtained, the habits and behaviors of the fish, statistical designs, statistical analyses made, laboratory conditions where the work was done, the reactions of each kind of fish, the suitability of each kind to laboratory conditions, and appropriate bibliographies. Data presented previously will not be repeated herein unless additional information is available.

ACKNOWLEDGMENTS

Without the help of certain persons and organizations a completed list of species would have been smaller and the work more difficult. Lawrence Bailliere, Ozark Fisheries, Stoutland, Missouri, helped greatly by showing how fish could be shipped and hauled in plastic bags with oxygen atmospheres and providing three species for testing. Jack Snow, U.S. Fish and Wildlife Service, Marion, Alabama, air expressed two species to us. Charles R. Walker, U.S. Fish and Wildlife Service, LaCross, Wisconsin, contributed time and collecting skill. Two species were received from the Georgia Game and Fish Commission, three were obtained from the Federal Hatchery at Tishomingo, Oklahoma, one from the Federal Hatchery at Neosho, Missouri, one from the Montana Fish and Game Department, two from the Federal Experimental Fish Farm at Stuttgart, Arkansas, four from the Arkansas Game and Fish Commission, two from hatcheries of Oklahoma Department of Wildlife Conservation,

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and one from the Tennessee Game and Fish Commission. The states of Iowa, Tennessee, Missouri, Kansas and Illinois provided men for field collecting in their respective states. Dr. Arthur Witt, University of Missouri, Dr. William M. Lewis, University of Southern Illinois, Harry H. Harrison, Madrid, Iowa and Dr. Robert J. Boles, Emporia State College, Kansas, gave time to provide fish specimens for the bioassay.

FISH AS TEST ANIMALS

Fish specimens of 1.5 to 3.0 inches in total length are desirable for bioassay(8). Large specimens are difficult to obtain, handle, feed, or keep healthy in the laboratory. Only a few kinds, whose adults are too large for acute toxicity test specimens, can be maintained, or obtained throughout the entire year.

Techniques for capture, transfer, transport, and feeding of fish are critical. Some fish cannot be captured readily by moving the seine but can be driven into a non-moving bag seine. All have particular places they inhabit and may change location frequently. Some fish are easily injured by scaling, bruising, temperature change, or because of fright. Many specimens of certain species appear to die of shock. Injured and ill specimens become reservoirs of infectious organisms for the apparently healthy ones. Information concerning food, *i.e.* kinds, frequency and volume necessary, are needed. Some fish have such rapid digestion and energy demand that they die from starvation during the 96-hour acute bioassay. Proper light intensity is necessary; fish have been killed in our laboratory by light-intensity, while other kinds were undisturbed. Noises, sudden or continuous, are detrimental to most wild forms while in laboratories. Explanation of effluent, diluent, problem design, TL_m determination, transportation, and foods for fish have been discussed in preceding papers. Not all collecting trips were successful: 500 to 1000 specimens of one kind are more fish than most collectors realize. On some occasions the fish could not be found; on others a different species than the one sought was collected. Often the species found had been used in previous tests. Many field trips were failures because we did not know the habitats or behaviors of particular species. Many species brought to the laboratory were not used in bioassay because they did not remain healthy in captivity. We believe with more information about their needs more kinds could be kept successfully in the laboratory. Some kinds of fish could be captured in small numbers and of unusable sizes day after day. Some kinds of fish were never obtained in large enough numbers to meet the design specifications. Although carp were common, we never found many of the small usable size in streams or lakes. A two-year search for *Notropis girardi*, known to be common, stopped one morning when about 5000 specimens were taken in a single seine haul. Specimens of three species, found in abundance in cold water streams originating from springs in northern Kentucky, died because the time required to carry the fish up the escarpment permitted the water temperature to rise faster than the fish could tolerate. Some shipments by air were exposed to too rapid a temperature change. Some species gave trouble during transportation and some contracted disease and could not be used as test animals. Columnaris and fin rot were the two most troublesome diseases. Some species refused to eat the food they were offered in captivity. At times several attempts at collection, transportation, and feeding were made before we provided the proper requirements.

SUSCEPTIBILITY

Scaling occurs readily on most small fish. The kinds vary greatly in their susceptibility. Scaling exposes the tissue, making infection possible. A disinfectant reduces loss greatly. Most specimens are disturbed greatly by handling, movement from one tank to another, or from streams to tanks. Seines and low water often frighten the fish. White bass, *Morone chrysops,* went into tetany when placed in shallow water and did not recover. Gizzard shad, *Dorsoma cepedeanum,* has been observed to leap from the water, go into tetany and die without being touched. We herded the gizzard shad into shallow water with a seine and transferred them from the stream to a tank with "cupped hands." Why this worked I do not know but gizzard shad so handled, survived transportation and lived in the laboratory tanks for 45 days. Many other attemps were fruitless.

Attempts were made to locate, transfer, and test 107 species, of which 57 were used in bioassays. Thirty-five of those used were collected from the waters of the Southwest and transported to the laboratory at Stillwater. Several were reared in ponds because only the adults could be found in the wild. Of the 22 others, some were purchased, some were contributed by state and federal hatcheries, and some were donated by commercial hatcheries.

RESISTANCE RANKINGS

Ranking of the species to show comparative resistance to petroleum refinery effluent was accomplished by computing a ratio between the average median tolerance limits of the reference species, the guppy (*Libestes reticulatus*), and each other species measured. The TL_ms involved were determined from tests in which both the reference species and the other species concerned were tested in concentrations made from the same effluent sample. Because the effluent varied in toxicity from sample to sample, the TL_ms compared were derived from tests which involved the reference species each time a species was tested. A ratio, average TL_m of *L. reticulatus* to average TL_m of

TABLE 1. RESISTANCE RANKINGS OF 24-HOUR TL_ms
Ratios of (1) an average of the TL_ms for each species to (2) an average of the TL_ms for the reference species tests that were associated with the specific species

Rank	Name	Ratio of Resistance
1.	*Libestes reticulatus* (Peters)	100.00
2.	*Fundulus kansae* (Garman)	91.44
3.	*Ictiobus cyprinellus* (Valenciennes)	89.36
4.	*Tilapia nilotica* (Linnaeus)	88.11
5.	*Ictalurus melas* (Rafinesque)	79.56
6.	*Gambusia affinis* (Baird and Girard)	79.05
7.	*Cyprinus carpio* (Linnaeus)	77.63
8.	*Notropis stramineus* (Cope)	70.95
9.	*Pimephales vigilax* (Baird and Girard)	70.49
10.	*Notropis cornutus* (Mitchill)	70.45
11.	*Notropis grairdi* (Hubbs and Ortenburger)	68.32
12.	*Ictalurus nebulosus* (LeSueur)	67.95
13.	*Lepomis auritus* (Linnaeus)	63.19
14.	*Fundulus olivaceus* (Storer)	62.83
15.	*Lepomis humilus* (Girard)	61.80
16.	*Eucalia inconstans* (Kirtland)	61.02
17.	*Notemigonus crysoleucas* (Mitchill)	60.73
18.	*Notropis whipplei* (Girard)	59.71
19.	*Notropis venustus* (Girard)	59.13
20.	*Pimephales promelas* (Rafinesque)	58.55
21.	*Hybosis amblops* (Rafinesque)	57.78
22.	*Hybognathus hankinsoni* (Hubbs)	56.93
23.	*Chaenobryttus gulosus* (Cuvier)	56.04
24.	*Lepomis microlophus* (Günther)	54.94
25.	*Ambloplites rupestris* (Rafinesque)	54.78
26.	*Campostoma anomalum* (Rafinesque)	54.32
27.	*Lepomis macrochirus* (Fafinesque)	53.36
28.	*Carassius auratus* (Linnaeus)	52.19
29.	*Hybognathus placitus* (Girard)	52.10
30.	*Chrosomus erythrogaster* (Rafinesque)	51.50
31.	*Micropterus salmoides* (Lacépéde)	50.98
32.	*Lepomis cyanellus* (Rafinesque)	50.64
33.	*Lepomis megalotis* (Rafinesque)	50.14
34.	*Notropis camurus* (Jordan and Meek)	48.67
35.	*Menidia audens* (Hay)	48.27
36.	*Pimephales notatus* (Rafinesque)	47.87
37.	*Ictalurus punctatus* (Rafinesque)	46.88
38.	*Notropis lutrensis* (Baird and Girard)	45.87
39.	*Pomoxis nigromaculatus* (LeSueur)	45.31
40.	*Labidesthes sicculus* (Cope)	44.78
41.	*Notropis boops* (Gilbert)	43.32
42.	*Esox lucius* (Linnaeus)	43.14
43.	*Micropterus dolomieui* (Lacépéde)	42.82
44.	*Notropis percobromus* (Cope)	42.78
45.	*Notropis spilopterus* (Cope)	42.14
46.	*Notropis zonatus* (Agassiz)	42.05
47.	*Dionda nubila* (Forbes)	39.09
48.	*Notropis dorsalis* (Agassiz)	38.05
49.	*Catostomus commersoni* (Lacépéde)	37.50
50.	*Notropis rubellus* (Agassiz)	36.80
51.	*Etheostoma spectabile* (Agassiz)	36.78
52.	*Noturus exilis* (Nelson)	36.17
53.	*Salmo gairdneri* (Richardson)	35.61
54.	*Semolitus atromaculatus* (Mitchill)	35.14
55.	*Salmo trutta* (Linnaeus)	30.01
56.	*Cottus carolinae* (Gill)	27.89
57.	*Dorosoma cepedeanum* (LeSueur)	21.74

L. reticulatus would be unity and was designated as one hundred. The reference species was the most resistant species for petroleum refinery effluent therefore all other ratios are below one hundred. Had a species been more resistant than the guppy the ratio of that one would have been more than one hundred.

Table 1 contains the rankings for the 24-hour and Table 2 those

TABLE 2. RESISTANCE RANKINGS OF 96-HOUR TL_mS
Ratios of (1) an average of the TL_ms for each species to (2) an average of the TL_ms for the reference species tests that were associated with the specific species.

Rank	Name	Ratio of Resistance
1.	*Libestes reticulatus* (Peters)	100.00
2.	*Fundulus kansae* (Garman)	91.44
3.	*Ictiobus cyprinellus* (Valenciennes)	89.36
4.	*Ictalurus nelas* (Rafinesque)	83.36
5.	*Cyprinus carpio* (Linnaeus)	76.63
6.	*Gambusia affinis* (Baird and Girard)	74.02
7.	*Tilapia nilotica* (Linnaeus)	72.94
8.	*Pimephales vigilax* (Baird and Girard)	72.63
9.	*Notropis stramineus* (Cope)	71.44
10.	*Ictalurus nebulosus* (LeSueur)	69.33
11.	*Notropis girardi* (Hubbs and Ortenburger)	66.89
12.	*Lepomis auritus* (Linnaeus)	63.04
13.	*Fundulus olivaceus* (Storer)	62.83
14.	*Lepomis humilus* (Girard)	61.80
15.	*Notropis cornutus* (Mitchill)	60.57
16.	*Ictalurus punctatus* (Rafinesque)	60.15
17.	*Notropis whipplei* (Girard)	59.62
18.	*Notropis venustus* (Girard)	56.62
19.	*Hybopsis amblops* (Rafinesque)	56.36
20.	*Hybognathus hankinsoni* (Hubbs)	55.74
21.	*Notemigonus crysoleucas* (Mitchill)	55.63
22.	*Chaenobryttus gulosus* (Cuvier)	55.24
23.	*Campostoma anomalum* (Rafinesque)	55.05
24.	*Ambloplites rupestris* (Rafinesque)	54.11
25.	*Lepomis macrochirus* (Rafinesque)	54.10
26.	*Micropterus salmoides* (Lacépéde)	53.27
27.	*Chrosomus erythrogaster* (Refinesque)	52.07
28.	*Carassius auratus* (Linnaeus)	51.95
29.	*Lepomis cyanellus* (Rafinesque)	50.28
30.	*Pimephales promelas* (Rafinesque)	49.19
31.	*Lepomis megalotis* (Rafinesque)	48.41
32.	*Eucalia inconstans* (Kirtland)	48.34
33.	*Lepomis microlophus* (Günther)	48.07
34.	*Notropis camurus* (Jordan and Meek)	47.90
35.	*Pimephales notatus* (Rafinesque)	47.37
36.	*Menidia audens* (Hay)	46.91
37.	*Pomoxis nigromaculatus* (LeSueur)	45.64
38.	*Hybognathus placitus* (Girard)	44.53
39.	*Notropis boops* (Gilbert)	43.62
40.	*Notropis lutrensis* (Baird and Girard)	43.44
41.	*Notropis rubellus* (Agassiz)	42.98
42.	*Labidesthes sicculus* (Cope)	42.80
43.	*Notropis zonatus* (Agassiz)	42.41
44.	*Notropis percobromus* (Cope)	42.07
45.	*Notropis spilopterus* (Cope)	41.82
46.	*Notropis dorsalis* (Agassiz)	38.05
47.	*Esox lucius* (Linnaeus)	37.31
48.	*Etheostoma spectabile* (Agassiz)	37.24
49.	*Catostomus commersoni* (Lacépéde)	37.10
50.	*Noturus exilis* (Nelson)	36.25
51.	*Micropterus dolomieui* (Lacépéde)	35.60
52.	*Semolitus atromaculatus* (Mitchill)	35.35
53.	*Salmo Gairdneri* (Richardson)	34.68
54.	*Salmo trutta* (Linnaeus)	32.32
55.	*Cottus carolinae* (Gill)	31.24
56.	*Dionda nubila* (Forbes)	20.97
57.	*Dorosoma cepedeanum* (LeSueur)	18.72

for 96-hour TL_ms. The ranked positions of a species for 24-hour and 96-hour tests are similar with the ratios of the 96-hour group smaller. In a few cases the 96-hour ratios are higher than those of the 24-hour group. This difference can be explained by the fact that the guppy varies in reaction to different chemicals (as do all kinds of fish) and the effluent used was different day by day. The effluent samples varied in content and stimulation and in some cases the resistance of the guppy decreased more for the 96-hour TL_ms than the resistance for the compared species did.

Ranking of Desirability of Species

Seven categories involving the desirability of species as laboratory animals are presented. Availability, size, health, adaptability to laboratory life, metabolic rate, acceptance of food and quiescent behavior in the test effluent are considered because in extreme cases any one of them could prohibit the use of a species from a short term, acute bioassay test[9]

1. A test animal must be available in goodly numbers, in proper size, be healthy and adaptable to laboratory life [8][11]. Availability of a species is likely to change from one part of the world to another. More species rate low on this category than on any of the other categories.
2. Specimens should be small (2.5 inches or less, total length) for acute bioassays. Size of the specimens limits the use of many kinds because the proper size may be abundant a few months only of each year[9]. Large specimens require too much room in every respect.
3. Health cannot be ignored. All fish can become ill but some are more prone to do so. Only healthy fish are acceptable bioassay animals.
4. Only fish that are adaptable to laboratory life are acceptible[8][10][11][12][13]. When frightened by sounds, shadows, or subject to disease when crowded, or if they possess a rapid rate of growth, they give trouble in laboratories. Some secrete so much mucus they foul the water rapidly. Those species that can be bred and reared in the laboratory are advantageous.
5. Metabolic rate tends to be at one extreme or the other. We found none that scored midway. A specimen that requires food during the test period presents difficulties. Food changes the effluent. Specimens in sublethal concentrations may lose their appetite and be killed from lack of energy rather than a poison. The lethal result may be from a combination of starvation and toxicity. Only a few fish were found with such

extreme requirements and were evidenced by those in the controls dying while the stock population, fed regularly, continued to be healthy.

6. Acceptance of food might be considered a part of adaptability to laboratory conditions. Few kinds refused to eat in captivity but when they did, the specimens deteriorated rapidly. Most frequently the fish would eat if the proper type of food was presented in the proper manner. Some eat only as the particles fall through the water and not from the bottom. A few will eat only at night and others have particular kinds of food which were acceptable. Frequently a food study of the species will provide helpful information. However, we had one species, common, and apparently hardy, that we could not maintain in the laboratory longer than 10 days although we tried repeatedly for two years without success to discover the reason. Later a high school boy showed us some of the same species he had kept in an aquarium for more than a year and didn't know it could not be done.
7. "Does not jump from the effluent" is a category which proves troublesome when it occurs[8]. Some species are habitual jumpers, leaving tanks that lack covers, others jump only when distressed. Both spoil tests and are undesirable test animals.

The species are ranked for the seven categories. Each is rated from 0 to 8 and the totals shown at the extreme right of Table 3. The rank positions for desirability (Table 3) differ from those ranked for resistance (Tables 1 & 2), in that the highest totals represent the most desirable species.

DISCUSSION

Probably no one species of fish possesses sufficient favorable testing characteristics to place it in a position above all others for use as an indicator of toxicity in bioassay. Some species are better than others because they possess many qualities that are desirable as indicators. Some are definitely unsatisfactory for use as a test species because of one to several undesirable characteristics.

The characteristics or traits of a species of fish should be considered before the fish is chosen as an important test animal in bioassay. Some traits undoubtedly influence the results obtained in determining median tolerance limits for a particular effluent. The most resistant species are not always the best test specimens. Weak effluents whose toxicity could not be detected by use of *L. reticulatus* might be measured by the use of *Lepomis cyanellus* as test animals. A species that is resistant to one factor may be sensitive to another.

TABLE 3. RANKINGS OF THE SPECIES AS SUITABLE TEST ANIMALS

		1	2	3	4	5	6	7	8
		Availability	Size	Health	Adaptability to Lab. life	Metabolic Rate	Acceptance of food	Does not jump from effluent	Total
1.	*Libestes reticulatus*	8	8	8	8	8	8	8	56
2.	*Gambusia affinis*	7	8	8	8	8	8	8	55
3.	*Pimephales notatus*	4	8	8	8	8	8	8	52
4.	*Pimephales promelas*	4	8	8	8	8	8	8	52
5.	*Pimephales vigilax*	4	8	8	8	8	8	8	52
6.	*Lepomis macrochirus*	5	7	8	7	8	8	8	50
7.	*Carassius auratus*	4	7	8	7	8	8	8	51
8.	*Chromsomus erythrogaster*	4	8	8	6	8	8	8	50
9.	*Lepomis cyanellus*	4	7	8	7	8	8	8	50
10.	*Notropis boops*	4	8	8	6	8	8	8	50
11.	*Notropis lutrensis*	4	8	8	7	8	8	7	50
12.	*Semotilus atromaculatus*	4	8	8	6	8	8	8	50
13.	*Tilapia nilotica*	4	6	8	8	8	8	8	50
14.	*Campostoma anomalum*	4	8	6	7	8	8	8	49
15.	*Chaenobryttus gulosus*	2	6	8	7	8	8	8	49
16.	*Etheostoma spectabile*	4	8	8	7	8	6	8	49
17.	*Fundulus olivaceus*	3	8	8	6	8	8	8	49
18.	*Labisdesthes sicculus*	4	8	8	7	8	6	8	49
19.	*Notropis zonatus*	2	8	8	6	8	7	8	49
20.	*Lepomis humilus*	2	7	8	7	8	8	8	48
21.	*Hybognathus placitus*	4	7	7	6	8	7	8	47
22.	*Lepomis megalotus*	3	6	8	6	8	8	8	47
23.	*Notropis cornutus*	2	7	8	6	8	8	8	47
24.	*Notropis percobromis*	4	8	6	6	7	8	8	47
25.	*Notropis stramineus*	2	8	7	6	8	8	8	47
26.	*Cottus carolinae*	2	8	6	6	8	8	8	46
27.	*Cyprinus carpio*	4	4	8	6	8	8	8	46
28.	*Eucalia inconstans*	4	8	8	8	2	8	8	46
29.	*Hybognathus hankinsoni*	2	8	6	6	8	8	8	46
30.	*Hybopsis amblops*	2	8	8	6	8	6	8	46
31.	*Ictalurus melas*	4	4	8	6	8	8	8	46
32.	*Notemigonus cyrsoleucas*	4	8	8	6	8	8	6	46
33.	*Notropis dorsalis*	2	8	8	4	8	8	8	46
34.	*Notropis girardi*	3	8	7	6	8	6	8	46
35.	*Notropis whipplei*	2	8	6	6	8	8	8	46
36.	*Ambloplites rupestris*	2	6	8	8	8	5	8	45
37.	*Lepomis microlophus*	4	7	8	6	8	4	8	45
38.	*Notropis venustus*	2	8	6	6	8	8	7	45
39.	*Micropterus salmoides*	2	4	8	6	8	8	8	44
40.	*Menidia audens*	2	8	6	6	8	6	8	44
41.	*Notropis camurus*	2	8	8	4	8	6	8	44
42.	*Lepomis auritus*	3	6	7	6	8	6	8	43
43.	*Ictalurus nebulosus*	2	4	8	4	8	8	8	42
44.	*Noturus exilis*	2	8	4	6	8	6	8	42
45.	*Ictalurus punctatus*	2	4	7	4	8	8	8	41
46.	*Ictiobus cyprinellus*	4	4	6	1	8	8	8	41
47.	*Notropis rubellus*	2	8	4	4	8	6	8	40
48.	*Dionda nubila*	1	8	6	3	7	6	8	39
49.	*Notropis spilopterus*	2	8	4	4	8	4	8	38
50.	*Pomoxis nigromaculatus*	2	4	6	4	7	6	8	37
51.	*Catostomus commersoni*	1	2	7	4	8	6	8	36
52.	*Micropterus dolomieui*	1	1	6	2	8	8	8	34
53.	*Fundulus kansae*	4	8	4	0	8	0	8	32
54.	*Esox lucius*	1	2	5	3	7	6	7	31
55.	*Salmo gairdneri*	1	1	2	2	2	8	8	24
56.	*Salmo trutta*	1	1	1	1	1	8	8	21
57.	*Drosoma cepedeanum*	1	1	1	1	4	4	8	20

Lebistes reticulatus, which was the most resistant to petroleum refinery effluent, was the most sensitive to low temperature.

Many of our preconceived ideas can be wrong. A better understanding of the ecology of fish and experience in handling them will change our minds and our results with many of the little-known kinds. Henderson and Pickering[14] say that Notropid species are difficult to keep and therefore poor test animals. We used fourteen species of *Notropis* of which some were excellent test animals and others gave us difficulty. The more we learned of their needs and habits the better test specimens they became. Their small size and abundance is in their favor.

A knowledge of species distribution within a study area is important. Specimens must be available and common at known locations throughout the year.

When using a single species of animal from a limited population, for bioassay of a single chemical, one would expect the TL_m values to be consistant, with a good average kill or survival at a given concentration. Some specimens of a population are likely to be extremely sensitive, some mildly so, and others not sensitive at all (resistant) to a given chemical. Another effluent sample with a different toxic chemical would produce entirely different TL_m values. Specimens sensitive to chemical number 1, could be resistant to chemical number 2 and so produce different ratios. The genetic formulae for sensitivities of fish have not been determined.

A species population in a continually polluted stream will be composed of fish with higher resistance than the original population or one collected from an unpolluted source. Specimens of the same species from another source should give the better test because local specimens have been selected for survival. This is contrary to the statements of authors concerning the selection of fish for bioassay animals[9]. The more sensitive, less selected population should give a better measure of the presence of a pollutant and not just a measure of the increase of a continually present pollutant.

Bioassay with 24-hour TL_m values seemed sufficiently long to determine the acute toxicity of petroleum refinery effluent. Most of the fish that succumbed in the longer tests did so before the 24-hour inspection period. So few died following the 24-hour inspection that the extra time required to produce 48-hour and 96-hour values seemed a waste of time and laboratory space. The 24-hour TL_m test would allow the presentation of a faster report.

SUMMARY

Fifty-seven kinds of fish were studied to determine their use as bioassay animals and their relative resistance to oil refinery effluents.

Seven papers, published and in press, derived from the study are summarized. Accepted bioassay methods were used; the effluent was taken directly at active refineries; and the fish were gathered from sixteen states. Variations in resistance and adaptability existed between both the kinds of fish and the individuals of a species.

The metabolic rates of individuals and species concerning oxygen, temperature and/or food requirements are limiting factors for some. Resistance rankings of fish; statistical treatments, quality items needed in specimens; behavior and life history; and suggestions for bioassay procedure are presented. The 24-hour median tolerance limits appeared to be as accurate as longer tests for the acute toxicity bioassay measurements when using oil refiinery effluents.

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DISCUSSION

DR. FRED BAUMGARTNER (Oklahoma State University): What species did you finally decide was probably the best one for the toxicity test?

DR. IRWIN: It makes a difference where you are working. In the northern part of the country, where it is cold, you can use trout. However, in Oklahoma we did not have much luck with trout. You can only use the little ones and only some of them.

The best one is a fish that you can grow in the laboratory and have available at the right size and in good biological condition. For example, minnows are excellent. Also, some sunfish, such as bluegills and green sunfish are excellent. Green sunfish are fine fish, but, are not found all over the United States. However, guppies, I think, range all over the United States.

DR. CAMPBELL (Missouri): I would like to ask if the fish that are most closely related were also similar in their responses.

DR. IRWIN: In some cases it works this way. As to the species of Pinnephates we ran three of them. There is a fourth that we could not find. However, all of these were very good and some were not good because we could not keep them in the laboratory. I think this is due entirely to the fact that we did not know how to handle them. If you are able to culture them, keep them happy and healthy, then any of the smaller fish would be better. In fact, I am sure that all the small ones could be used. You can always get some of the larger ones, such as the carp. However, you cannot use them because they will jump out of the water and give you trouble. Further, they will be different next week from this week. In other words, they keep you guessing.

MISS JUANITA MAHAFFEY (United States Public Health Service): I have no questions to ask of the speaker but I couldn't pass up this golden opportunity to mention one thing and, therefore, if I may be permitted to do so, I would like to do so.

I have reference to an effort that we have been conducting over the past five years in connection with our water pollution control program and that is to assemble and gather from the state fish and game agencies reports on pollution kills in our streams. We have reason to believe that we are not getting nearly all of these reports in from the numerous fish kills that do occur from pollution.

Right now, for example, I happen to be working on the report for the year 1964. It was a record year and we do not have all of the reports. However, we do know that we are getting a great many press releases from people around the country reporting fish kills for which there are no matching reports from state fish and game agencies. Therefore, in connection with those of you who can do something about prodding your respective states, we would very much appreciate it if you can see that all of them are reported.

VICE CHAIRMAN SCHONING: That is a very appropriate advertisement and request.

MR. BOB MEEKS (Ohio State University): It is known that certain containers will have certain effects on your bioassays. I was wondering whether the glass containers were better or merely what your opinion was?

DR. IRWIN: In this case, the containers we used were better than glass because they were cheaper and they did not break. Further, we had no difficulty with the refineries because you are dealing with a different case here than when you are dealing with pesticides, etc. In connection with pesticides, we would recommend that you go to glass.

COORDINATED SANDHILL CRANE STUDY IN THE CENTRAL FLYWAY

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This paper presents information on crane migrations, seasonal distributions, numbers, racial composition, and crop depredations. Data were obtained during the first 3 years of a 4-year cooperative study conducted by the Bureau of Sport Fisheries and Wildlife and the Central Flyway Council.

Three species of *Gruidae,* including little brown, sandhill and whooping cranes, were defined as migratory game birds in formal conventions between the United States, Great Britain (for Canada) and the United Mexican States. The little brown and sandhill cranes have subsequently been shown to represent two well-marked subspecies of the same species (*Grus canadensis*). The little brown crane is now called the lesser sandhill (*G. c. canadensis*), and the former "sandhill crane" is now called the greater sandhill (*G. c. tabida*). Legislative authority for the hunting of migratory birds in the United States is contained in the Migratory Bird Treaty Act of July 3, 1918, as amended (40 Stat. 755; 16 U.S.C. 703). On May 26, 1916, a closed season was established on the little brown cranes. The closure remained in effect until January 1, 1961, when a 30-day season was authorized in eastern New Mexico and western Texas where they occur alone. Sandhill cranes of both subspecies have been hunted in Mexico for years, and during the fall of 1959, Saskatchewan farmers were permitted to shoot these birds under general crop depredation orders.

The Central Flyway Waterfowl Council and the National Flyway Waterfowl Council requested consideration of a limited season on lesser sandhill cranes in the United States. The Saskatchewan Department of Natural Resources and the Canadian Wildlife Service recommended favorable consideration of the Councils' proposal. Studies by Aldrich and Burleigh (1958), Huey (1960), and Allen (1952) concluded that few, if any, greater sandhill cranes or whooping cranes (*Grus americana*) occur in the proposed hunting area. In view of these considerations, the Secretary of the Interior authorized the first hunting season on lesser sandhill cranes in portions of New Mexico and Texas.

The first lesser sandhill crane season was held in eastern New Mexico between the dates of January 1 and 30, 1961. Texas was unable to participate since cranes were not classed as game birds by

State statute. This was followed by 30-day seasons in Alaska (September 1-30) and in New Mexico and West Texas (November 4-December 3) in 1961. Similar seasons were authorized in succeeding years with minor changes; the area open to hunting in New Mexico and Texas was enlarged slightly, and the hunting period in Alaska was increased to 45 days during the 1964-65 waterfowl season. Residents of Saskatchewan and Manitoba were permitted a limited season on both subspecies of sandhill cranes between the dates of September 1 and 19, 1964.

Harvest data, obtained during the 1961 lesser sandhill crane seasons in New Mexico and Texas (Boeker *et al.*, 1961 and 1962), prompted the Central Flyway Waterfowl Council to request an enlargement of the hunting area at its August 1962 meeting. The resolution proposed that the Council and the Bureau explore the possibilities of extending the season to other states of the flyway. It was agreed that before this proposal could be accepted, it would be necessary to firmly establish that enlargement of the hunting area would not endanger the whooping crane. These internationally famous birds have been sighted in North Dakota, South Dakota, Nebraska, Kansas, Oklahoma, Saskatchewan and Alberta during fall migration. Sandhill cranes stop over in many of these areas.

Another problem in extending the range of the lesser sandhill crane hunting season concerned the migration route of the greater sandhill crane. This larger race was present in collections of cranes made in the Horsehead Lake region of southcentral North Dakota during the fall of 1959 and 1960. The possibility that this race may be present in other areas favored by migrating cranes is also recognized. Therefore, racial composition of fall migrating sandhill cranes and the timing of the fall migration of whooping cranes were included as objectives of the 4-year cooperative study, initiated in the fall of 1962.

OBJECTIVES

The objectives of this study are:

1. To determine the number, time of arrival, and departure of sandhill cranes throughout the Central Flyway (New Mexico and Texas excluded) during the fall migration.
2. To delineate the major congregation areas of sandhill cranes in the Central Flyway during the fall migration.
3. To determine the racial composition of sandhill crane flocks in the Central Flyway during the fall migration.
4. To correlate data concerning the fall migration of sandhill cranes and whooping cranes in the Central Flyway.

5. To locate and document crop depredations by sandhill cranes during the fall migration.

PROCEDURES

Standard waterfowl survey techniques were used to gather data for Objectives 1, 2, 4 and 5. Information pertaining to the racial composition of fall migrating cranes was obtained from a selective collecting program and a recently developed field technique which involves measuring footprint impressions.

Justification for using footprint measurements for identifying the races of cranes is based on measurements obtained at the Bitter Lake and Bosque del Apache National Wildlife Refuges in New Mexico in 1960 and 1961 (Boeker *et al.*, 1961). At Bitter Lake, a known wintering area for lesser sandhill cranes, 160 midtoe measurements (posterior edge of the ball of the foot to, but not including, the claw) taken at random ranged from 76mm. to 95 mm. in length and averaged 86.5 mm. At Bosque del Apache, a major wintering area for greater sandhill cranes, 142 midtoe measurements taken at random ranged from 100 to 123 mm., and averaged 111 mm.

Field personnel were instructed to measure at random a minimum of 100 distinct footprint (midtoe) impressions around roost sites or in heavily utilized fields in the centers of greatest crane use.

FINDINGS TO DATE

Chronology of the fall migration, peak populations and congregation areas.

Alberta—The first migrating sandhill cranes were observed on lakes, rivers and reservoirs of southeastern Alberta about mid-September. During the study, peak numbers—3,000 to 4,500—were noted in the Grassy Island-Gooseberry-Sounding Lake area near Consort the first week of October. Cranes using this general area are probably a part of the population that stops in the Kindersley District, Saskatchewan.

Saskatchewan—The first migrants normally reach the Kindersley District in the Southwestern section of the Province the latter part of August. The population peaks at about 50,000 during the last week of September, and departures start about mid-October. Another 25,000 are estimated to occur along the South Saskatchewan River in the last week of September. These birds also depart in mid-October.

Migrant sandhills arrive in the Last Mountain Lake-Quill Lakes area of southcentral Saskatchewan in early August. The population peaks at about 25,000 during the last week of September, and departures begin in mid-October.

Manitoba—The first migrants reach the Big Grass Marsh on the southwestern shores of Lake Manitoba about mid-August. The population peaks at about 6,000 to 7,000 birds during the first half of September and remains somewhat stable until mid-October.

Migrating cranes also use The Pas area, but specific information concerning arrival and departure dates and peak numbers is lacking.

Montana—Migrating cranes were noted in northeastern Montana (Phillips, Valley, Sheridan and Garfield Counties) in late September or early October. In 1962 and 1963, the peak numbers of cranes stopping at Bowdoin, Charles M. Russell, and Medicine Lake National Wildlife Refuges totaled about 10,000, and departures ranged from early November to early December. The flocks that migrated through the state during the fall of 1964 rarely stopped over for more than a brief rest.

About 300 cranes reside in the vicinity of Red Rock Lakes National Wildlife Refuge (Beaverhead County) from April to mid-September. Some of these birds nest in this area.

North Dakota—First arrivals in the Horsehead, Kunkle, Sibley, Schumacher and Iowa lakes area, an important way station in central North Dakota, ranged from late July to the third week of August. Peak numbers varied from 8,000 to 15,000 in mid-October, and departures began in early November. Departures in 1964 were triggered by a cold front, snow and high northwesterly winds.

In 1963 and 1964, fall migrating cranes were observed on sloughs, lakes (Nettie, Turtle, Brush and Williams), and grainfields in McLean County. First arrivals in 1963 were noted September 11; in 1964, the first cranes were observed August 1. Peak numbers ranged from 4,800 in late September, 1963, to 7,000 on November 2, 1964. Departures began in the forepart of November each year.

From late September to early November, sandhills use the Missouri River from the Montana line to the Nisson Bottoms east of Williston, and from Bismarck to the South Dakota line. Peak numbers in the Nisson Bottoms area probably do not exceed 1,000. On October 14, 1964, 5,200 birds were counted along the river between Bismarck and the South Dakota line.

South Dakota—Sandhill cranes arrived in the Pollock-Mobridge area of northcentral South Dakota (Campbell and Walworth Counties), the center of greatest use, about September 10 each year. Peak populations ranged from 9,500 to 18,000 during the latter part of October, and departures began in mid-November.

The DeGrey area, Hughes County, was used as a way station by migrant cranes until it was inundated in 1964 by Big Bend Reservoir. About 3,500 birds were noted here November 10, 1963, but only 9 birds were observed on this date in 1964.

Nebraska—Large numbers of sandhill cranes rarely stop over in Nebraska during the fall migration period. The first migrating flocks reached the western and central sections of the state the forepart of October in 1962 and 1963. In 1964, the first migrants were observed near Oshkosh, Garden County, September 9. The peak of the fall migration occurred in mid-October, and the last migrant flocks were observed in mid-November.

The North Platte, South Platte and Platte Rivers and adjacent grainfields from Lewellen to Grand Island constitute an important way station for spring migrating cranes. Birds enroute north usually arrive in the Platte River Valley about mid-February, and during the third week of March this population has ranged from 240,000 (1958) to 102,000 (1963). Departures begin within 1 or 2 weeks of the peak population date.

Wyoming—The principal way stations for the cranes that migrate through Wyoming are in the southeastern section of the state (Albany, Platte and Goshen Counties). First arrivals were noted the forepart of September, and birds that stop over reach peak numbers in mid-October. About 1,600 birds were noted at Pole Creek Reservoir October 19, 1963; however, flocks numbering approximately 12,000 birds have been observed in migration. Pole Creek, Hawk Springs, Springer and Sinnard Reservoirs received the greatest use during the 1963 fall migration. The 1964 fall migration reached Wyoming during the forepart of October, but Glendo Reservoir, with 5,000 to 6,000 birds on October 9, was the only important way station.

Colorado—Fall migrating cranes usually arrive in the San Luis Valley in the southcentral part of the state during the first week of September. First arrivals reach Prewitt Reservoir (Washington County), an important way station in northeastern Colorado, 4 to 6 weeks later. Peak numbers at Prewitt Reservoir reached 20,000 birds in 1962 and 1963; however, the period of stopover varied between years. In 1962, the birds stopped off for less than 1 week; in 1963, they utilized this area for a month. The 1964 fall migration bypassed Prewitt Reservoir, and 500 birds was the greatest number that stopped over.

Bonny Reservoir (Yuma County) and Lake Meredith, Blue Lake and Two Buttes Reservoir in the Arkansas Valley serve as way stations for smaller numbers (500 to 2,000) of migrant sandhills. Arrivals and departures at these areas coincided with crane movements at Prewitt Reservoir.

Kansas—Migrating sandhill cranes were observed at Kirwin National Wildlife Refuge (Phillips County) in northcentral Kansas, from October 20 to November 28, 1963, and at Quivira National Wildlife Refuge (Stafford County), from October 13 to November 11, 1963. The first 1964 migrants reached Quivira Refuge on September 26. In 1963, the Kirwin Refuge Population peaked at 250 birds November 7-15, and 810 were recorded November 6 at Quivira Refuge. In 1964, the Quivira population peaked at 1,850 on October 6, and 460 were noted November 20 at Cheyenne Bottoms Waterfowl Management Area (Barton County).

Oklahoma—First arrivals at Washita National Wildlife Refuge (Custer County), an important way station in western Oklahoma, were noted in the latter part of October. In 1963, the population peaked at 7,000 birds during the second week of December; the 1964 population peaked at 15,000 on November 25. A mass departure was triggered by cold fronts and snow storms each year.

Racial composition of migrating sandhill cranes.

A total of 3,492 sandhill crane footprint (midtoe) measurements was obtained as an aid to determining the racial composition of cranes congregating on refuges, lakes, reservoirs, sloughs, sandbars, mud flats and grainfields within the centers of greatest use. These measurements indicate that the cranes utilizing the principal stopover areas in the Central Flyway have the following composition:

Bowdoin National Wildlife Refuge, Montana (134 measurements): 40% lesser; 60% intermediate (*G. canadensis* > *tabida*) 8% intermediate or greater.

Kidder and Stutsman Counties, North Dakota (960 measurements): 86% lesser; 14% intermediate or greater.

McLean County, North Dakota (279 measurements): 92% lesser; 8% intermediate or greater.

Campbell and Walworth Counties, South Dakota (726 measurements): 97% lesser; 3% intermediate or greater.

Goshen County, Wyoming (157 measurements): 55% lesser; 45% intermediate or greater.

Prewitt Reservoir, Colorado (500 measurements): 100% lesser.

Arkansas Valley, Colorado (147 measurements): 92% lesser; 8% intermediate or greater.

Kirwin and Quivira Refuges, Kansas (347 measurements): 50% lesser; 50% intermediate or greater.

Washita Refuge, Oklahoma (200 measurements): 68% lesser; 32% intermediate or greater.

Midtoe measurements obtained during August, September and October in Kidder and Stutsman Counties, North Dakota, were analyzed to determine if the races of sandhill crane exhibit differential migration dates. Of 277 measurements obtained in August and September 18% fell within the range of the intermediate or greater; of 683 obtained in October, 13% fell within the range of these races.

The possibility that the midtoe measurements of juvenile greater sandhills may fall within the range of the lesser sandhill midtoe length was investigated in 1964. At Monte Vista National Wildlife Refuge, Colorado, the midtoe measurements were obtained for 11 greater sandhills hatched from eggs gathered at Malheur National Wildlife Refuge, Oregon. Measurements obtained at 49 to 57 days of age ranged from 97-108 mm. (average 103.6 mm.); at 79 to 88 days of age, the measurements ranged from 98-112 mm., and averaged 106.4 mm. (Knoder, 1964). It was concluded, therefore that juvenile greater sandhill cranes may be distinguished from lesser sandhill cranes by the midtoe measurement before they reach flight stage at 75-80 days of age.

Data on the racial composition of fall migrating sandhill cranes are also available from a selective collecting program during and preceding the study. Birds were collected with a high-powered rifle equipped with a telescopic sight; thus, it was possible to collect the larger-appearing birds.

During the study, 26 birds were taken in North Dakota—16 in Horsehead Lake area and 10 in McLean County—and 22 were taken in the Pollock-Mobridge area, South Dakota. Three sandhill cranes, confiscated October 10, 1964, from goose hunters in the vicinity of Salt Plains National Wildlife Refuge, Alfalfa County, Oklahoma, and two cranes illegally killed in the vicinity of Devils Lake, North Dakota, October 2 or 3, 1964, were also made available for racial determination. In addition, the racial composition of 25 cranes collected in the Horsehead Lake area of North Dakota during the fall of 1959 and 1960 was reviewed.

Racial determinations made by Dr. John W. Aldrich, Staff Specialist for the Bureau, indicate that 15 of the cranes taken in South Dakota were typical lessers; the remaining 7 were intermediate between greater and lesser sandhills. North Dakota-collected birds were identified as: 21 lessers, 24 intermediates, 5 greaters, and 1 possible greater. The Oklahoma birds were identified as lessers. The birds illegally killed in North Dakota were identified as a lesser and an intermediate.

Footprint measurements obtained in September indicate that the flocks found in North Dakota at this time may contain few typical lessers. This is supported by the collection program, which suggests that the lessers may be more numerous in October than in September.

Correlation of the data on the fall migration of sandhill and whooping cranes in the Central Flyway.

The most important consideration in extending the lesser sandhill crane season to states other than New Mexico and Texas involves the possibility of jeopardizing the rare whooping crane. To resolve this problem, all reported sightings of fall migrating whooping cranes were checked for authenticity and correlated with the sandhill migration.

Five verified and six probable sightings of whooping cranes were recorded between August 23 and November 30, 1962 (Boeker, 1963). One verified report was received during the fall of 1963, and 7 verified and 3 probable sightings were received between the dates of September 11 and November 3, 1964. The location of these sightings and the verified and probable sightings of migrating whooping cranes during the fall of 1959, 1960 and 1961 (Boeker, 1960, 1961 and 1962) are shown on Figure 1. Included are the principal congregation areas used by migrating sandhill cranes.

Figure 1 shows concurrent use by fall migrating whooping and sandhill cranes during the past 6 years of the following areas: Last Mountain Lake and Quill Lakes, Saskatchewan; McLean, Kidder and Stutsman Counties, North Dakota; Mobridge-Pollock area, South Dakota; and Kirwin and Quivira Refuges, Kansas. Sandhill crane congregation areas outside the 1959-64 fall migration route of whooping cranes include those in Montana, Wyoming and Colorado.

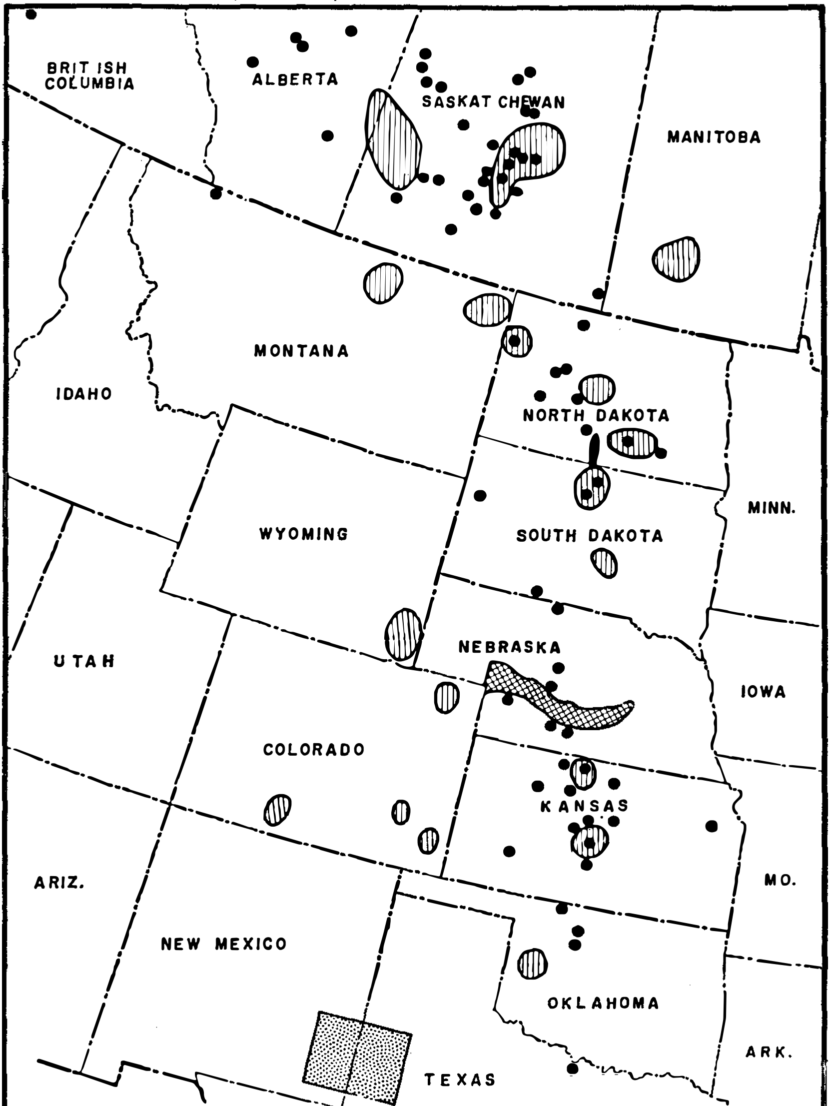
During the 1959-64 period, whooping cranes were observed in these areas on or between the following dates:

Last Mountain Lake-Quill Lakes, Saskatchewan—Sept. 15 to Oct. 20
Kidder and Stutsman Counties, North Dakota—Sept. 22
McLean County, North Dakota—Sept. 24
Mobridge-Pollock area, South Dakota—Sept. 11 to Sept. 29
Kirwin and Quivira Refuges, Kansas—Oct. 26 to Nov. 1

Crop depredations by sandhill cranes

Sandhill crane depredations on grain crops have been documented by Smith and Boeker (1958), Timmerman (1958), Munro (1950), Linduska (1949), Sperry (1939), Sooter (1943), Nelson (1961), and Mackay (1962). The 1961 experimental crane seasons in New Mexico and Texas were authorized to alleviate crop depredations in Saskatchewan and the northern states of the flyway by reducing the size of the crane population. Thus, documentation of crop depreda-

FIGURE I. – LOCATION OF VERIFIED AND PROBABLE SIGHTINGS OF FALL MIGRATING WHOOPING CRANES 1956-64, AND SANDHILL CRANE CONGREGATION AREAS, 1962-64.



● WHOOPING CRANE OBSERVATIONS   SANDHILL CRANES: FALL WINTER SPRING

Figure 1. Location of verified and probable sightings of fall migrating whooping cranes 1959-64, and sandhill crane congregation areas, 1962-64.

tions by cranes was included as an objective of the coordinated study.

1962—A mail questionnaire survey which was conducted throughout the Prairie Provinces of Alberta, Saskatchewan and Manitoba showed that sandhill cranes depredated extensively on standing and harvested cereal crops in the Kindersley, Last Mountain-Quill Lakes and Big Grass Marsh areas.

Sandhill cranes fed on grain crops in the Kidder-Stutsman County area of North Dakota; however, the nature and extent of the depredations were not learned. It was also reported that no depredation control was practiced by farmers during the goose season in this area since these control activities have a dispersing effect upon the geese.

Approximately 30 farmers reported moderate to heavy crane depredations on corn, sorghum, and winter wheat and rye in the Mobridge-Pollock area, South Dakota.

1963—Crop depredations by cranes during the 1963 fall migration were negligible. The lack of depredation complaints was attributed to the mild, clear weather which permitted farmers to harvest their crops before the peak of the fall migration.

One complaint of crop depredations by cranes was registered in the San Luis Valley, Colorado.

1964—No complaints of crop depredations by cranes were registered in the flyway. Cranes were reported to have fed on swathed grain in the Horsehead Lake area, North Dakota. A killing frost in early September caused farmers to "chop" their corn for silage.

A late August frost and a dry fall accelerated the grain harvest in South Dakota. Cranes in the Mobridge-Pollock area fed in cornfields into which cattled had been turned.

In Kansas, sandhill cranes were observed to occasionally feed in winter wheatfields, but no depredation complaints were registered.

SUMMARY

The 1961 lesser sandhill crane seasons in New Mexico and Texas prompted a coordinated study to obtain information on the chronology of the fall sandhill and whooping crane migrations, peak populations and areas of greatest use, racial composition of migrating cranes, and crop depredations by sandhill cranes in the Central Flyway. This information was obtained in response to a resolution from the Central Flyway Council, which requested that the 1961 hunting seasons be extended to other states of the flyway.

During 1962 and 1963, the vanguard of the fall migration reached congregation areas in Canada and North Dakota about mid-August;

in Montana and South Dakota during the last week of September and the first week of October; in Wyoming about September 10; in Colorado during the second and third weeks of October; in Nebraska and Kansas about mid-October; and in Oklahoma in the last week of October. In 1964, the first fall migrants arrived in North Dakota during the first week of August, and migrating flocks were observed in Nebraska about 5 weeks earlier than in 1962 and 1963. Generally, the fall migration proceeds at a leisurely pace except when mass movements are triggered by cold fronts.

Crane numbers peak in Saskatchewan congregation areas during the latter parts of September and October, and the first week of November at the principal stop-over areas in Montana, North Dakota, South Dakota, Wyoming and Colorado. Crane populations numbered 50,000 birds in the Kindersley District and 25,000 in each of the remaining Saskatchewan congregation areas—South Saskatchewan River and Last Mountain Lake-Quill Lakes. A minimum of 50,000 birds were present in the areas of greatest use in the United States during the fall of 1963.

Sandhill cranes usually depart from the Canadian areas in mid-October; departures from fall congregation areas within the states of the Central Flyway occur throughout November and the forepart of December.

Footprint (midtoe) measurements of cranes using Prewitt Reservoir, Colorado, indicate that this segment of the population were lesser sandhill cranes, and midtoe measurements indicate that this race predominated in the North Dakota, South Dakota, Wyoming, Oklahoma and the remaining eastern Colorado areas of greatest use. These measurements also indicated that the greater sandhill or representatives of the population intermediate between the two races may predominate at the Montana and Kansas way stations and that the cranes stopping off in the San Luis Valley, Colorado, are of the greater variety.

Fifteen of 22 cranes collected in the Mobridge-Pollock area, South Dakota, were identified as lessers; 22 of 53 cranes taken in North Dakota were also identified as lessers. Footprint measurements and the collection of specimens in September indicate that the first migrating flocks of sandhill cranes to reach the principal way stations in North Dakota contain unknown numbers of the greater race or intermediates and that these are gradually replaced or diluted by the more numerous typical lessers from the Far North.

The fall migration of the whooping crane is sometimes concurrent in time and place with the sandhills, and during the past 6 years (1959-64) whooping cranes have been observed with sandhills at congregation sites in Saskatchewan, North Dakota, South Dakota and Kansas, which are far removed from areas open to lesser sandhill crane hunting in the U. S. No whooping cranes have been observed during the past 6 years at sandhill crane congregation areas in northeastern Montana, southeastern Wyoming, eastern Colorado or western Oklahoma.

Cranes feed on standing and harvested grain crops throughout the flyway. Depredation control measures are not practiced in the principal North Dakota congregation area during the goose season since farmers believe that these measures have a dispersing effect upon the geese.

ACKNOWLEDGMENTS

The writers are indebted to many individuals throughout the Central Flyway who painstakingly collected data for this study. We are especially grateful to Alex Dzubin, W. R. Miller and W. J. D. Stephen, Canadian Wildlife Service, for supplying data from the Prairie Provinces; to U. S. Game Management Agents W. Ashton Brann, Harry A. Jensen, David W. Fisher, R. E. Meyer, Loren J. Bonde, Charles R. Hayes, H. B. Lyman and Alfred J. Robinson, Jr., for coordinating the study within their assigned districts; to Jerome H. Stoudt for collecting many of the cranes; to Dr. John W. Aldrich for racial determinations; and to numerous State technicians and refuge managers for supplying fall migration and population data and footprint (midtoe) measurements.

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DISCUSSION

DISCUSSION LEADER SCHONING: Thank you very much, Ray.

You commented on the implication of some increased hunting pressure on the Sandhill Crane. To those of us who have never hunted this bird, I would be interested in comment from you on the hunting qualities of the crane and, if you are fortunate enough to get one, its eating qualities compared to some of the other game birds.

MR. BULLER: In answer to that question, having hunted cranes a time or two, they are as smart or smarter than the Canadian geese. The most fruitful way of hunting them is through the use of decoys. They will respond to decoys and to a goose call if you modify it to imitate the call of the crane, which, in turn, will cause them to swing or come over your decoy set-up.

Insofar as the edible qualities are concerned, they are just as tasty or perhaps even more so, than are geese.

MR. ROLAND CLEMENT (National Audubon Society): I would like to ask Mr. Buller whether a field check was made on at least some of the reports of damage resulting from the questionnaire? In other words, was some follow-up made to evaluate the ecological situation which existed at the time the damage was reported?

MR. BULLER: First with respect to the questionnaire which was conducted in Canada—this was conducted by the Canadian Wildlife Service and I cannot answer as to whether or not a follow-up check was made.

With regard to the definition of complaints within states, these were checked by United States game management agents and in some instances cranes did create damage to both swathed or standing grain. Does that answer your question?

MR. CLEMENT: In part.

I am simply trying to emphasize the point that by inviting reports of damage through a questionnaire approach, the Service may be letting itself in for perhaps an exaggerated picture of the situation.

In other words, there is also the anticipation that perhaps something will be done and, therefore, it is easy to ascribe damage to a cause that somebody will make up rather than some other cause.

MR. BULLER: I would like to toss the ball here, if I may, Mr. Clement, to Dr. Dave Munro of the Canadian Wildlife Service, who perhaps can answer the question regarding the questionnaire in Canada. In the states we did not use a mail questionnaire to inquire about crane damage. The complaints are registered either in person or by telephone to the local USGMA agent who then goes out and makes a field check.

DR. CLARENCE COTTAM (Texas): I would like to ask the speaker if he has any evidence whatever that the hunting of the Lesser Sandhill Crane has done any damage to the Greater Sandhill Cranes? After all, this was the main thing in years gone by, and I hope you are concerned with it as much as we.

After all, the Greater Sandhill Crane is easy to distinguish in the hand but, as you have already indicated, it is very difficult to identify in the field, from the standpoint of the hunter telling whether he has shot any other species.

MR. BULLER: Insofar as the seasons in New Mexico and Texas are concerned, Dr. Cottam, there have been only Lesser Sandhill Cranes killed. This is on the basis of hunter bag data collected by qualified personnel, who are taking weights and measurements and other criteria relative to racial determination.

Insofar as causing irreparable damage to the population, in connection with the Lesser Sandhill Crane, let me quote you some figures relative to New Mexico and Texas.

In January 1961, New Mexico was only one of the two states which was allowed and which could participate in the crane season. Texas would have liked to but, by a quirk of nature, the Sandhill Crane was not defined as a game bird by state statutes so they were not able to participate.

In January 1961, 542 cranes were estimated to have been killed in New Mexico.

In the November season of 1961, the figure was a thousand cranes in New Mexico and 1,900 in Texas. We are now estimating that the total kill in New Mexico and Texas probably will not exceed 4,000 and this maybe somewhat high.

VICE CHAIRMAN SCHONING: In answer to the earlier question from Mr. Clement, you referred the remainder of your answer to Dr. Munro.

DR. DAVID MUNRO (Canada): With regard to the question, we did not systematically assess the results obtained by the questionnaire. However, for something in the vicinity of 17 or 18 years, we have, on a fairly regular basis, been investigating Sandhill Cranes in various parts of the Canadian prairies and we have also been subjected, through that period of time and even earlier, to complaints from the farmers in that area of the prairies.

There is no question at all that the damage that is done to individual farmers in some cases can be of an extent which may eliminate their profit margin and which they certainly have to maintain. I agree with the suggestion that when you circulate a questionnaire it is quite possible that you may find people complaining about something they would otherwise put up with. This is a risk, I believe, you have to run. If you have a problem, after all, you then have to try your best to define it, to determine what its limits are, to decide whether it is serious, also what warrants this or that kind of action.

I can see no other way in which we could have attempted to define this problem than by a series of questionnaires such as we distributed.

I would also like to say a word or two with regard to certain aspects of the circumstances in Canada. Mr. Buller outlined in great detail the concentration areas, the kinds of movements, etc. I think he did an excellent job and made a real contribution to our knowledge in this respect.

He mentioned several areas in Canada where concentration took place. Of the last two he mentioned, they were the Quill Lake Area and the Big Grass Marsh Area in Manitoba, where concentrations, while not the largest, are mostly confined and where great amounts of damage do occur. It was in these two areas, within limited scope of several townships in extent, that the season was opened this last year, during the period September 1st to September 19th.

With regard to the damage problem in Canada, I would like to say it is a more serious problem than in the United States. This is for the reason that the cranes arrive in concentration earlier and, also, our season is later. Therefore, the arrival of the cranes and the presence of partly harvested grain is much more likely to be concidental than it is as they proceed down the flyway.

MR. DYER (University of Ontario): Considerable emphasis has been placed on bird hazards with regard to aircraft in recent years, and I was wondering if you are gathering information on the flight lines and whether these are of potentially any danger to commercial and small private and military aircraft. This is a very serious problem. Will you comment on this?

MR. BULLER: I am not personally acquainted with any crane strikes against airplanes. Perhaps there is someone in the audience who can talk about this.

POND CULTURE OF OYSTERS—PAST, PRESENT, AND FUTURE

WILLIAM N. SHAW
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The history of oyster culture in ponds dates back at least to the first century B. C. (Yonge, 1960). Designs on Roman vases reveal that oysters were cultivated in Lucrene Lake, Italy, by hanging them from horizontal stakes. Dean (1893) reported that the Roman methods of oyster culture were still in use in Italy. He stated that seed oysters were collected in Lake Fusaro on bundles of branches known as fascines, grown to market size, and then placed in baskets for final conditioning or fattening. He also described the method of oyster culture at Lucrene Lake, where the water was renewed by opening heavy flood gates in a massive sluiceway projecting into the sea. Here, as at Lake Fusaro, oysters were grown on fascines and fattened in baskets.

Oysters were cultured in ponds in Holland and Belgium for many years (Dean, 1893). In Holland the ponds were used mainly for growing seed oysters, but in Belgium oysters were fattened for the market in ponds.

In a unique method of pond culture in Norway, oysters are suspended in wire cages at mid-depths because the bottom water has no dissolved oxygen (Yonge, 1960). Spawning occurs here, and the larvae attach to branches that have been interlocked in wire netting. Mortalities can be high if the bottom and middle layers of water mix.

France has probably developed pond culture of oysters further than other European countries. Small oysters, "caught" on roofing tiles, are placed in tidal ponds. Just prior to marketing they are transferred to special rectangular basins (50 by 150 feet) called *claires,* where the oysters attain a creamy consistency and the gills acquire a highly prized green color. Oysters in claires may double their weight in 6 months (Yonge, 1960).

Dean (1892) described the production of seed oysters in a pond in France. The pond was drained and the bottom allowed to dry for 2 months, supposedly to kill animal and plant life. It was then filled, and mature oysters were stocked at the rate of about 40 per square yard. The outlet and inlet of the pond were blocked to trap the larvae soon after the oysters had spawned. An excellent set was caught on tiles placed on the bottom. Unfortunately, it is not known how successful this method was in later years.

The United States appears to be at least 100 years behind European countries in the development of oyster culture in ponds. The commercial use of ponds has been very limited, even though pond culture could be practiced in many areas along the East Coast.

Several experiments have been conducted in the United States to develop the pond culture of oysters. One of the first was on the shore of Chincoteague Bay, Md. (Ryder, 1883). A 50-square-yard pond was excavated in a salt marsh and connected to a bay by a trench 10 feet long, 2 feet wide, and 3½ feet deep. A set of oysters from ¼ to ¾ inch long was observed 46 days after fertilized eggs were placed in the pond. The experiment proved, in Ryder's estimation, that ponds or enclosed areas of water may be used readily for culturing oysters along the eastern coast of the United States. Lunz (1956) studied the culture of oysters in small ponds at Wadmalow Island, S. C. The studies were terminated after heavy mortalities, believed to have been caused by a fungus, *Dermocystidium*. Carriker (1959) made extensive studies on the culture of oysters and clams in Home Pond, Gardiners Island, Long Island Sound, N. Y. He concluded, "that utilization of salt-water ponds for the cultivation of such benthic species as oysters and *Venus* on a large scale is feasible; predictable success, however, must be predicated upon further extensive basic research." Loosanoff (1956) wrote that growing oysters in ponds has the advantage that they are protected from storms, and the control of enemies is feasible. The results and opinions of these investigators indicate that the pond culture of oysters in the United States does have a commercial potential.

Basic research on the culture of oysters in tidal ponds was initiated by the Bureau of Commercial Fisheries in 1956 at Chatham, Mass. Seed oysters strung on galvanized wire (Figure 1) were suspended from a log raft moored in Oyster Pond River from spring through fall, and in Oyster Pond during the winter. Attempts to grow small oysters on the bottom had failed in this area because of predation by drills and whelks.

The suspended oysters grew rapidly; average shell height was slightly over 2½ inches after only 1 year. At the end of 2 years the height of 75 percent of the oysters was more than 3 inches, the legal market size in Massachusetts. Marketable size thus was attained in 2 years by suspending oysters off the bottom, whereas 3 to 4 years normally are required for seed oysters to reach marketable size in New England when they are grown on the bottom. Mortality was low because the raft-grown oysters were not preyed upon by drills and whelks. The development of raft-grown oysters in the tidal ponds of Cape Cod appeared to be commercially feasible (Shaw, 1962).

Further studies were conducted in Taylors Pond, West Chatham, Mass. The growth of four strains of oysters was compared (Shaw and McCann, 1963), and seasonal changes in condition (fatness) of suspended oysters were measured (Shaw, 1963). These experiments showed that certain strains of oysters grew faster than others and that suspending oysters off the bottom greatly improved their condition. Thus, an oyster of superior quality, suitable for serving on the half-shell, can be grown commercially in the tidal ponds of New England by off-bottom culture techniques.

For the past 4 years, a private company at Fishers Island, N. Y., has produced large quantities of seed oysters. Each spring the outlet of a 28-acre pond was blocked off during the spawning season to trap oyster larvae. A total of 25,000 7-foot strings, to which bay scallop shells were attached, were suspended from 125 rafts to catch

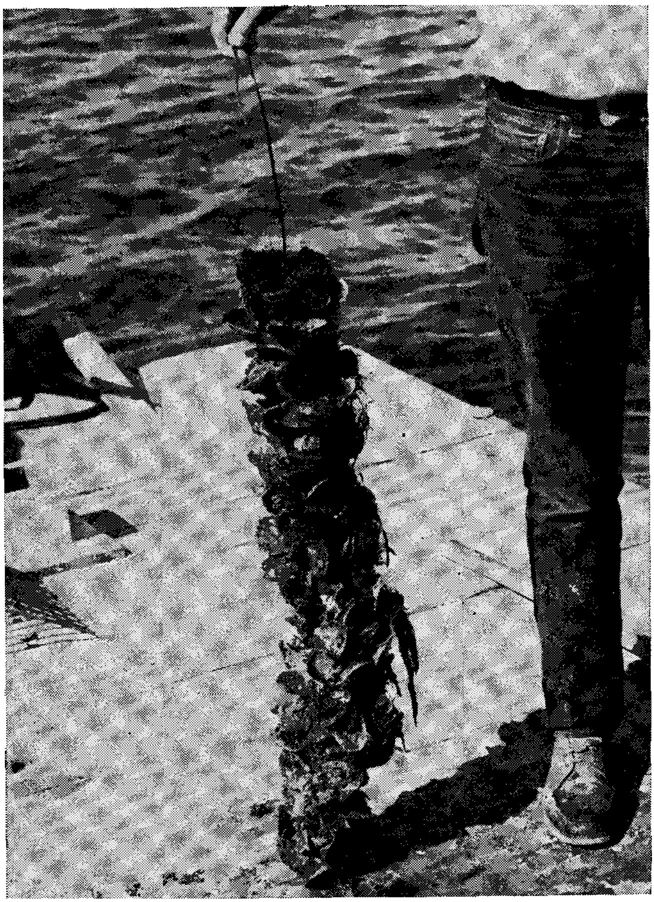

Figure 1. String of raft-grown oysters.

sets of oysters. In 1964, 10,000 bushels of seed oysters were harvested; an increase to 15,000 bushels is planned for 1965 (Binmore, 1964).

Extensive research on the culture of oysters in natural ponds is being carried on by the Bureau of Commercial Fisheries Biological Laboratory, Oxford, Md. In 1964 a rigid structure, 108 by 12 feet, was constructed in a tidal pond adjacent to the laboratory to test the feasibility of growing oysters commercially in tidal ponds of the Chesapeake Bay region. More than 1,000 strings of seed oysters were suspended from this structure (Figure 2) and 2,000 more are to be added in the fall of 1965. It is anticipated that a total of 1,500 bushels of oysters will be harvested from these strings after 2 years.

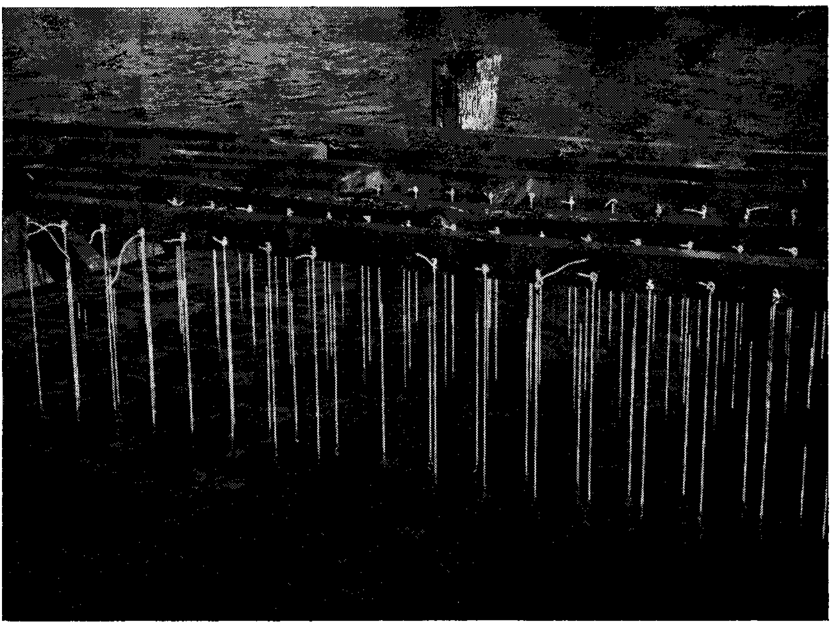

Figure 2. Strings of seed oysters attached to a wooden structure in a natural salt-water pond adjacent to the laboratory in Oxford, Md.

Beaven (1954) wrote that, "The use of small enclosed and artificially fertilized ponds for production of seed oysters might also be a possibility and would offer opportunity for experiments with selective brood stocks. Unfortunately facilities for this type of experiments are not now available in Maryland." This statement is no longer true.

Experiments are now in progress at the Oxford Laboratory on the

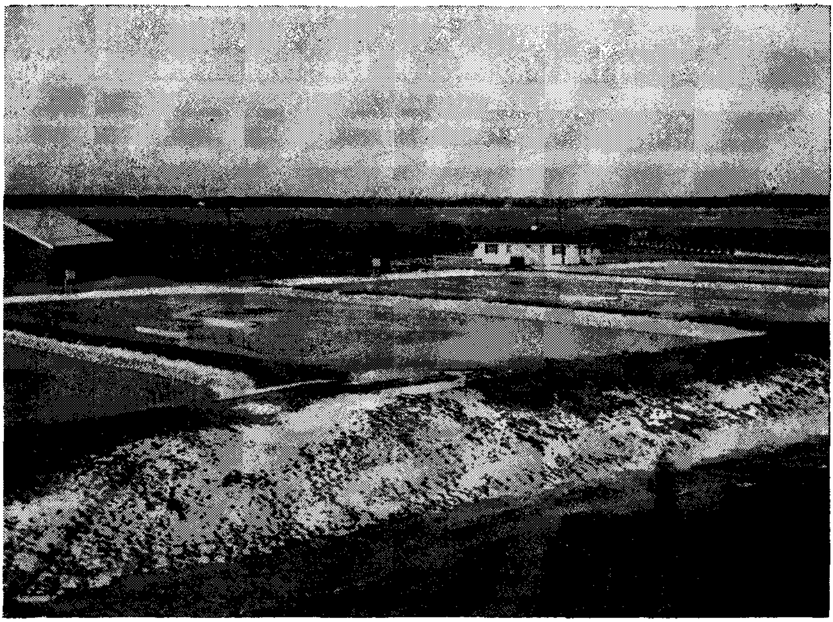

Figure 3. Four ¼-acre artificial, salt-water ponds located near the laboratory in Oxford. Pump house is in upper left hand corner and the Tred Avon River, source of water for ponds, in background.

culture of oysters in four ¼-acre artificial salt-water ponds (Figure 3). Water is pumped to each pond through a dual system at the rate of more than 80 gallons per minute. Baffles at the outlets of each pond control the water level to any desired depth below 3¼ feet. Environmental factors such as temperature, salinity, and amount of food organisms can be regulated to a considerable extent because large volumes of water can be exchanged readily (the ponds can be drained or filled within 24 hours).

In one pond seven strains of oysters from the seed producing areas of the Maryland portion of Chesapeake Bay are being studied for differential growth and survival. The shell size of each strain is measured periodically to determine growth rate. Strains that show fast growth can be used in future experiments on selective breeding.

In another pond, four types of bottom materials—clay, sand, oyster shell, and polyethylene film—are being tested to determine which is most suitable for growing oysters. Fifty bushels of oysters, averaging 2 to 3 inches in shell height, have been planted on each bottom type. Size, condition, and rate of survival are determined monthly.

Future plans include studies on the potential production of seed oysters in artificial ponds by methods that have been successful in France (Dean, 1892) and at Fishers Island, N. Y. (Binmore, 1964). In addition, oyster larvae will be reared in the laboratory and released in the pond, where suitable collectors have been placed. Other future studies may include the development of techniques for fattening oysters, either by addition of fertilizer to increase phytoplankton production or by adding phytoplankton, grown in the laboratory, to the pond. The studies will be aimed at determining whether oysters can be cultured commercially in man-made ponds.

In a 1958 address to the National Shellfisheries Association, Paul S. Galtsoff stated, "The future welfare of the oyster industry calls for the solution of the following problems: reliable production of seed oysters; production of rapidly growing oysters with high-glycogen and high-solid contents; selection of disease resistant races; improvement of methods of self-purification of oysters; scientific evaluation or appraisal of oyster bottom based on their productivity capacity; and development of oyster pond culture in tidal marshes and other areas not used at present for oyster farming."

The recent pond studies in Massachusetts and Maryland are beginning to solve some of these problems, to attempt to help an industry whose landings have declined since the turn of the century. C. M. Yonge (1960) stated: ". . . the probability of a future for the oyster industry [will be] based largely on the results of intensive research at laboratories. . . ." This research is now being conducted at the Oxford Laboratory, not only to develop methods of pond culture, but also to determine what kills oysters, and to find methods to eradicate or control the causes of mortalities (Engle and Rosenfield, 1962). Similarly, intensive research on the commercial feasibility of culturing oyster larvae in hatcheries is being carried out at the Bureau's Biological Laboratory in Milford, Conn. (Loosanoff and Davis, 1963). It is unlikely that oysters ever will be as numerous as in the late 1800's, but it is hoped that this shellfish will again become sufficiently abundant to be removed from the category of a luxury food.

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DISCUSSION

DISCUSSION LEADER SCHONING: Thank you very much, Bill.

I noticed there are a number of commissioners and administrators in the audience and they always seem to be forever thinking about costs in operations. Therefore, I wonder if you would comment on the relative cost of the propagation of oysters as compared with present costs?

MR. SHAW: This was one of the first problems we had to look at, of course, the cost of culture. Immediately you lift the oyster off the bottom, you increase cost.

The first studies were done up on Cape Cod, Massachusetts, where the oysters at that time were sold for about $12.00 a bushel. From our early studies we found that the oysters we produced up in those waters was at a cost feasible to commercial growers. Now then, oysters are worth $16.00 a bushel in Massachusetts and so I think this method is even more feasible than back in 1960.

I would say that the most difficult problem here is that you are starting from scratch. You have to put out considerable money and then you have to wait at least two years or even three years before you realize any profit. This is sometimes discouraging to many oyster growers or the oyster industry.

CHAIRMAN LAWRENCE: I would like to ask for a little elucidation of your comment on the green colored oysters—whether they are not marketable because of taste or whether there is some real reason. I would like to mention also that I purchased a bushel of oysters this past week and quite a few were green and I was told by the oyster authority this was as the result of copper in the water. At any rate, I ate them, enjoyed them and thus far have not suffered any ill effects.

MR. SHAW: Well, this green coloring can be related to copper—this is true. However, this is not the case in France and was not the case in the incident I reported.

The green color is basically found in the gills of the oyster and comes from what the oyster is eating. For example, an individual out in Chesapeake Bay sent me a sample of oysters and wanted to know what the green coloring was and we summarized that it was due to material in the water that it was eating at that time. This individual further commented that because of his green coloring he had no market for the oyster.

DIFFERENTIAL VULNERABILITY OF MALE AND FEMALE CANVASBACKS TO HUNTING

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Considerable effort has been devoted to the study of waterfowl in hunter's bags and to the analysis of banding returns to determine the effects of hunting on the sex and age structure of waterfowl populations; however, except for discussions of crippling losses, the behavior of living ducks in the actual hunting situations has received comparatively little attention. Hochbaum (1944) found more females than males in the canvasbacks shot by hunters in Manitoba and suggested that hunting may be a factor in the disproportionate sex ratio of canvasbacks. Smith (1946) found more juvenile than adult canvasbacks in hunter's bags, but indicated that "no flight or decoying differences were noted in the age classes." In a study of mallards responding to decoys Anderson (1947) found that juvenile females received more shooting pressure than drakes. Tendencies for higher mortality rates in female than in male canvasbacks have been reported from banding data by Geis (1959) and DeGraff *et al.* (1961). Bellrose *et al.* (1961) summarized banding and hunter bag statistics of many species of North American ducks including canvasbacks and concluded "the effect of hunting on the sex ratios of the entire North American duck population is probably insignificant." Thus, there seems to be little agreement in the literature concerning the effects of hunting on the composition of waterfowl populations.

This report describes an attempt to record and analyze the behavior and subsequent mortality patterns of canvasback ducks as they responded to decoys and flew across shooting passes in southern Manitoba in 1960. The study is part of a larger investigation of population dynamics in canvasback ducks which was conducted from 1958 to 1962, (Olson 1964).

Preliminary observations of migrating canvasbacks and inspection of hunter's bags in the autumn of 1958 and 1959 indicated that adult male canvasbacks did not appear in hunter's bags in the same proportion as they existed in the wild populations. In aerial and ground surveys of canvasback populations at Oak Lake and the Delta Marshes, Manitoba, 25-30 percent of the canvasbacks were adult males. In contrast, only 5-10 percent of the canvasbacks in hunter's bags were adult males. Narratives of hunters and guides suggested that there were behavioral differences between canvasbacks, because most hunters claimed a preference for shooting the larger, bright-colored males. It was also observed that guides used predominantly female colored decoys in the marshes which are frequented by adult females and juveniles, but they used predominantly male colored decoys on the larger lakes frequented by adult males. These clues and others led to the intensive study of canvasbacks in hunting situations as described below.

POPULATION SURVEYS

Canvasback populations on the study areas at Oak Lake, Dauphin Lake, and the Delta Marshes in southern Manitoba were periodically censused from an airplane and on the ground to determine the chronology of fall migration and the proportion of adult males present on the study areas. During September and October the juvenile canvasbacks of both sexes resemble the adult females in general plumage color. The adult males, however, are distinctly brighter and can be readily identified as they fly across passes, or respond to decoys, or when counted from an airplane during surveys. Thus, two major categories: "white"—adult males and "brown"—adult females and juveniles were used in this study. Whenever possible the sex and age composition of the "brown" canvasbacks was more accurately ascertained by detailed examination with field glasses or by selective shooting.

DECOY EXPERIMENTS

The objectives of the decoy studies were: (1) to determine if the sex and age classes of canvasbacks responded to decoys differently; (2) to determine if canvasbacks exhibited a preference for decoys painted as female or male canvasbacks; and (3) to determine if canvasbacks responded differently to varying numbers of decoys. For most experiments 50 decoys, 25 painted as males and 25 painted as females, were used. Usually the decoys were placed in two groups with 25 males in one and 25 females in the other group approximately 50 yards away with the observer between the groups or on the side, Figure 1. Occasionally 25 decoys either all male, all female or mixed were set out. The decoys were evenly spaced and placed in approximately circular patches so that the arrangement could be duplicated in successive trials.

A total of 1,761 canvasbacks in 669 flocks were observed and recorded responding to the decoys which were set out 27 times between August 24 and October 31, 1960. For purposes of recording and tabulation one canvasback responding to decoys alone was considered a "flock" as was any group of two or more canvasbacks, and each flock was recorded on a separate card, Figure 2. Every canvasback

Figure 1. Typical arrangement of canvasback decoys at Dauphin Lake, Manitoba

which responded to the decoys was recorded as: landing (in or near decoys); low; medium; or wide. The low, medium, and wide are subjective ratings in terms of shotgun range. In general, low corresponds to 40 yards or less, medium 40-60 yards, and wide beyond 60 yards. For most of the observations a written description of the flight into and/or around the decoys was also recorded, see 'comments' in Figure 2.

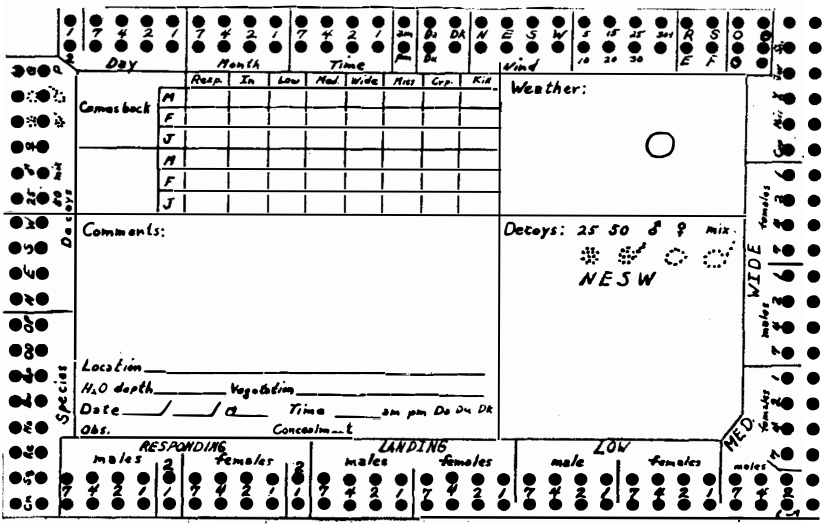

Figure 2. Punch card form used for recording responses of canvasbacks to decoys

The adult female and juvenile canvasbacks were markedly more vulnerable to hunting over the decoys than were the adult males. In 858 observations of females and juveniles responding to decoys, 597 or 70 percent either landed in or flew low over the decoys, Table 1. In a comparable 883 observations of adult male canvasbacks, only 360 or 41 percent landed in or flew low over the decoys. Thirty-two percent of the adult females and juveniles actually landed in or near the decoys as compared to 19 percent of the adult males. In the "brown" birds which were accurately identified as to sex 29 of 46 females landed in the decoys. The written descriptions of the flights into the decoys revealed that adult males tended to circle outside the decoys without landing while the females and juveniles frequently flew directly in and landed in the decoys.

TABLE 1. COMPARATIVE RESPONSES OF 1,741 CANVASBACKS TO DECOYS MANITOBA, AUGUST 24 TO OCTOBER 30, 1960

	Adult Males					Adult Females and Juveniles				
Date	landing	low	med.	wide	total	landing	low	med.	wide	total
8/24–9/29	68 53%	28 22%	13 10%	19 15%	128	123 41%	131 43%	15 5%	33 11%	302
9/30–10/31	101 13%	163 22%	158 21%	333 44%	755	152 27%	191 34%	82 15%	131 24%	556
Total	169 19%	191 22%	171 19%	352 40%	883	275 32%	322 38%	97 11%	164 19%	858

The patterns of vulnerability changed somewhat as the fall migration progressed. In September, when the canvasback population was mostly females and juveniles, all of the canvasbacks including adult males responded to the decoys more directly by landing or crossing lower. In October, when the canvasback population was mostly adult males and the canvasbacks were distributed in larger flocks, the canvasbacks responded to the decoys more warily. However, throughout the entire fall migration the responses of females and juveniles showed they were more vulnerable to shooting over decoys than were the adult males.

Rather different responses of canvasbacks to 25 and 50 decoys were obtained, especially in the later half of the fall migration when canvasbacks responded to 50 decoys more readily than to 25 decoys. In trials conducted between September 30 and October 31 at Dauphin Lake 16 percent of 376 adult males and 44 percent of 220 adult females and juveniles either landed or flew low over 25 decoys. In comparison 58 percent of 238 adult males and 86 percent of 175 adult females and juveniles landed or flew low over 50 decoys. In September, during the earlier part of the migration, there was considerably less difference in the responses of canvasbacks to 50 and 25 decoys.

As judged by differences in behavior, the canvasbacks also exhibited some preference for decoys of their own color (sex). In the adult male responses only 8 percent of 258 birds either landed or flew low over 25 female decoys, but 33 percent of 117 birds landed in or flew low over 25 male decoys. The differences in response of birds in the adult female and juvenile category was reversed: 28 percent of 135 canvasbacks landed or were low over 25 female decoys, but 52 percent of 85 canvasbacks landed or were low in the 25 male decoys. Part of this reversal seems attributable to juvenile males which are catagorized with the adult and juvenile females. Of 30 juvenile males which were accurately identified, 22 exhibited preferences for male decoys. The differences in response to decoys painted as males or females was most pronounced in October when most of the canvasbacks were males. Thus, it can be said that male canvasbacks show a clear preference for male decoys, but adult and juvenile females are not as selective.

BEHAVIOR OVER A SHOOTING PASS

Observations of canvasbacks flying across a typical pass at Oak Lake, Manitoba were made on 5 mornings and 7 evenings during September and October. The number of canvasbacks in each flock, color (white or brown), time, direction, and height in terms of shotgun range (low, medium and high) were recorded. Miscellaneous observations such as turning or circling over the pass, tendency for males to lead flocks and weather conditions were also noted.

The adult females and juveniles were more vulnerable to shooting over the Oak Lake pass than were the adult males. The females and juveniles tended to cross lower than did the adult males, Table 2. They also tended to turn or circle over the pass and often they crossed the pass diagonally, thus allowing greater opportunity for shooting. Adult males, on the other hand, usually circled over the water well away from land, then crossed the pass directly and quickly. In addition, the females and juveniles appeared over the passes proportionately more than the adult males. Of the 2,218 canvasbacks observed 1,812 were females or juveniles and only 406 or 14 percent were adult males, Table 2. In comparison the population of canvasbacks at Oak Lake contained between 25 and 61 percent adult males (Table 3).

Adult male canvasbacks tended to lead the flocks in which they were flying. Of 62 flocks examined 39 (63 percent) were led by drakes but only 35 percent of the birds in the flocks were males.

TABLE 2. COMPARATIVE BEHAVIOR OF CANVASBACKS OVER A SHOOTING PASS OAK LAKE, MANITOBA—1960

	Adult Males				Adult Females and Juveniles			
	low	med.	high	total	low	med.	high	total
9/11–9/18	28 18%	37 23%	95 59%	160 100%	556 43%	367 28%	385 29%	1308 100%
10/2–10/4	27 11%	108 44%	111 45%	246 100%	91 18%	205 41%	208 41%	504 100%
Total	55 14%	145 36%	206 51%	406 100%	647 36%	572 32%	593 33%	1812 100%

This "leading" may be a factor in male mortality since hunters often try for the lead duck in a flock.

Canvasback flocks crossing the pass during the first one-half hour after dawn and the last 30 minutes before dusk flew lower than flocks crossing in the brighter portions of the day, and the canvasback flocks also tended to cross the pass lower on cloudy than clear days.

FLOCK SIZE IN RELATION TO VULNERABILITY

The distribution of canvasbacks according to the size of flocks observed in the decoy trials and pass observations has been plotted in Figure 3. It is apparent from Figure 3 that female and juvenile canvasbacks have a greater tendency to occur in small flocks than do the adult males. There were more than twice as many single adult female or juvenile canvasbacks as there were single adult males and the proportion is almost two to one for flocks of two and three. Hochbaum (1944) also noted on the Delta Marsh that "most strays, singles, twos and threes are females."

TABLE 3. PROPORTION OF ADULT MALES TO ADULT FEMALE AND JUVENILE CANVASBACKS IN: POPULATIONS, RESPONSE TO DECOYS, AND PASS OBSERVATIONS

Date	Location	Population*	Decoys	Pass
8/24–9/6/60	Delta Marsh	31:69 (254)	60:40 (127)	
9/10–9/23/60	Delta Marsh	38:62 (953)	27:73 (105)	
9/11–9/19/60	Oak Lake	25:75 (3,338)	14:86 (180)	11:89 (1,468)
9/27–9/30/60	Dauphin Lake	84:16 (3,673)	57:43 (413)	
10/2–10/5/60	Oak Lake	61:39 (2,997)	49:51 (239)	33:67 (250)
10/28–10/31/60	Dauphin Lake	81:19 (7,890)	61:39 (596)	

* Ratios obtained by aerial surveys and checked by ground observations.

The probability of mortality (upper axis in Figure 3) was obtained by assuming that the average hunter kills or mortally wounds one canvasback for every two shooting opportunities. A single canvasback or a flock of canvasbacks responding to decoys or crossing a shooting pass can be considered a shooting opportunity. Thus, one can examine the number of canvasbacks in the various flock sizes in relation to estimated mortality. From Figure 3 it can be seen that individual ducks in the smaller flocks have greater probabilities of mortality than those in larger flocks; therefore, on the basis of distribution in these flock sizes, the female and juvenile canvasbacks appear to be much more vulnerable to hunting than do adult males.

The behavior of canvasbacks in small flocks also indicates that they are more vulnerable than canvasbacks in larger flocks. Single canvasbacks and doubles, whether adult males or females and juveniles, had a greater tendency to cross the pass low and to fly over the decoys low or land in the decoys than did the canvasbacks in flocks of three or more. However, it should be noted that, even in flocks of three or more, the adult females and juveniles are more vulnerable

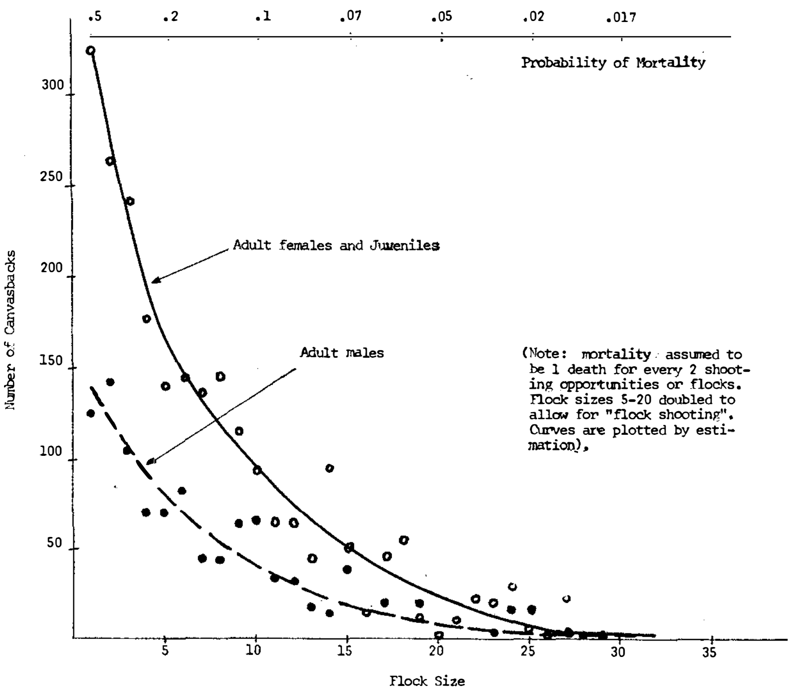

Figure 3. Number of canvasbacks by flock size and estimated mortality

than adult males, and, therefore, their greater vulnerability is not due entirely to small flock sizes or to the behavior of canvasbacks in these small flocks.

The average flock size of canvasbacks responding to decoys was 2.5, while flocks crossing the pass averaged 5.7 birds. Much of this difference is caused by major flights or movements of canvasbacks, such as morning and evening feeding flights, which frequently cross the passes. Decoys, on the other hand, tend to draw only a few responses from these large movements.

DIFFERENCES IN ACTIVITY IN MALE AND FEMALE CANVASBACKS

The data in Table 3 indicates that proportionately more adult females and juveniles flew across the pass or responded to decoys than were present in the canvasback populations on the study areas. These differences were found in all the census periods except for the earliest observations on the Delta Marsh. This seems to indicate that adult females and/or juvenile canvasbacks are more active or tend to fly more than adult males. Observations during censuses at Oak Lake in 1959 and 1960 tend to support this explanation. The flocks of canvasbacks flying over large rafts of canvasbacks on the water frequently contained greater proportions of brown birds (females and juveniles) than were present in the flocks on the water, and when I alerted flocks of canvasbacks by my presence, the females and juveniles were usually flying before the adult males.

To further check for differences in activity, a study was made on a flock of captive adult canvasbacks at the Delta Waterfowl Research Station. Repeated observations, both indoors in winter and outdoors in summer, and by two independent observers resulted in the conclusion that females were more active than males. Of course, a tendency for greater activity of captive female canvasbacks can in no way be equated to a greater disposition to fly across shooting passes or into decoys, but it does suggest that females, especially adult females, are more active than adult males.

EFFECT OF FEMALE VULNERABILITY ON SEX RATIOS

The data presented here indicate that canvasback females and juveniles are decidedly more vulnerable to hunting over decoys and on passes than are adult males. The distribution in smaller flock sizes and tendency of females to be more active than males are also mortality factors which bear heavily on females. Although there is need for additional investigations of this kind, these facts suggest that the differences in vulnerability to hunting may be the cause of an imbalanced sex ratio in canvasback ducks.

Since canvasback females appear to be more vulnerable to hunting than are adult males, they should be killed earlier in the season and at a younger age than the adult males. McIlhenny (1940) found this to be true for lesser scaups, ring-necked ducks, and pintails whose males did in fact outlive the females. Geis (1949) demonstrated slightly higher mortality rates for females than for males in some populations of canvasback ducks but not in others. In a study of canvasbacks banded in New York State the females exhibited higher mortality rates than the males, DeGraff *et al.* (1961). Bellrose *et al.* (1961) examined the year of banding returns from canvasbacks banded by Ducks Unlimited between 1939 and 1950 on the Prairie Provinces of Canada and tabulated a slight, but non-significant tendency for proportionately fewer males in hunter's bags. In general the differences in the mortality rates of male and female canvasbacks as reported from these banding data appear not large enough to produce the observed spring sex ratios of approximately two males per female in the known life span of canvasback ducks.

In view of the greater vulnerability of female canvasbacks to hunting one may well ask why the mortality rates are as closely balanced as reported? Apparently, the adult females are killed in excess of adult males until the canvasback population contains approximately twice as many males as females and then the males become more vulnerable due to their relative abundance and are killed in excess of females. The estimated balance point of 65 percent males is suggested by the spring sex ratios which for many years have been approximately two males per female, (Hochbaum 1944, and Olson, 1964).

The following data support the suggestion that there is a point where the numerical abundance of male canvasbacks balances against female vulnerability. Bellrose *et al.* (1961) listed proportions of male canvasbacks in the kill from: Manitoba, 41 percent; North Dakota, 56 percent; and Illinois, 65 percent. Geis (1959) reported for certain populations of canvasbacks a similar tendency for females to die before males in the hunting season. Of course, these differences in the composition of the kill could also be obtained if hunting seasons in the various states matched the differential migration of the sexes. On wintering areas there is a tendency for females to be killed in excess of males except where populations contain more than 65 percent males:

	Population	Kill
New York	77% ♂♂	73% ♂♂
Maryland	65% ♂♂	58% ♂♂
Louisiana	66% ♂♂	51% ♂♂
North Carolina	55% ♂♂	42% ♂♂

Although these data are from a wide variety of sources (Longwell and Stotts [1958], DeGraff et. al. [1961], Critcher [1949] and personal communications) and include data from different years and some small samples, they do suggest that the kill of male and female canvasbacks follows predictable patterns and that the sex ratio in hunter's bags is equal or contains more males than females only after the population contains somewhat more than 60 percent males.

MANAGEMENT IMPLICATIONS

If, as this study indicates, the disproportionate sex radio in canvasbacks is produced by the gun, corrective measures may be within the realm of management possibilities. Many canvasback hunters now selectively shoot drakes and it seems that more could be encouraged to do so. However, simply encouraging hunters to kill drakes will have no beneficial effect on canvasback populations or productivity unless some means are found to protect females from indiscriminate shooting. If the females are not adequately protected, encouraging hunters to shoot males will simply make more females vulnerable by removing the males which act as a buffer. Similarly, special regulations for protection of females in the northern parts of the flyways, such as Hochbaum (1948) has advocated for Manitoba, will have no real effect unless females are protected along the entire flyway. On the other hand, hunters in wintering areas are in a particularly favorable position to practice selective shooting and thereby increase the proportion of females going back to the breeding areas each spring.

The results obtained in the decoy trials and pass observations provide some possibilities for manipulating the kill of canvasbacks by sexes. Pass shooting seems to be particularly hard on female canvasbacks, and therefore, regulations might be proposed to discourage pass shooting and encourage the use of decoys. Pass shooting is best in the periods of poor light such as dawn, dusk, and cloudy days, and under these conditions there is less chance for selection of males. The use of decoys offers the further advantage of smaller flock sizes and greater possibility for visually selecting male canvasbacks. The indications that male canvasbacks will respond better to all male decoys and to larger numbers of decoys may eventually provide a means of selectively decoying males. For instance, one easily enforced regulation would be the requirement for using all male canvasback decoys. Laws such as Manitoba has had which restrict hunters to 25 decoys or the current low bag limits in the United States tend to promote the shooting of females since hunters are discouraged from setting up large spreads of decoys, which are more attractive to males.

In any scheme for managing the canvasback kill by sexes the overall greater vulnerability of the female stands out as the most important single factor and indicates that recognition of male and female canvasbacks and abstinence from shooting females may well be required from hunters. At Delta, Manitoba most canvasbacks in hunter's bags occurred as one or two juveniles or adult females in a mixture of several species shot by hunters using mallard or mixed decoys or shooting over passes. In other words, the average shooter who attempts to kill whatever comes into the decoys or across the passes far outnumbers the devoted canvasback hunter who might select males. However, due to the relatively great difference in color of plumage, requiring the recognition of canvasbacks by sex seems at least as reasonable as distinguishing between certain species of ducks such as ring-necked ducks, scaup, and redheads which has already been asked of hunters. In addition, the abstinence from shooting female canvasbacks, or any other nondescript colored duck for that matter, may actually lead to desirable increases in the quality of the sport.

ADDITIONAL RESEARCH NEEDS

The results from these studies are limited in many ways, and a great deal of research will be required to determine the vulnerability patterns of canvasbacks in other areas. My communications with hunters on the Chesapeake Bay and at the Bear River Marshes in Utah indicate that females are more vulnerable than males in both areas, but that this pattern can vary markedly with changes in weather and season. In addition to studies in different areas and at various times during the season, there is need to evaluate the effects of weather, canvasback behavior in actual shooting situations, and a greater variety of hunting methods and decoy combinations. If the studies are carried out after November 1, the juvenile males and females will have attained distinct plumages and the problems in identification of sexes will be greatly simplified. Because of restricted seasons and limitations in manpower most of the observations reported in this paper are without actual shooting. Canvasback behavior may be conspicuously different when they are being shot at, and the kill composition during the study periods would provide valuable comparisons with canvasback behavior patterns. It should be mentioned that shooters cannot be fully aware of differences in behavior. This was apparent in the comments of hunters, when during the course of this study, they laid down their guns and watched.

There is reason to believe that different vulnerability patterns may exist between the sexes in many species of ducks. Recently, Harmon (1962) reported a sex ratio of 4.36 males per female in large rafts of lesser scaup off the Louisiana coast. During the same winter Louisiana hunters bagged one male scaup for each female in a sample of 111 birds checked (pers. comm. Morton Smith). The tendency of males to (1) occur in large flocks, (2) migrate later in the fall, and (3) use large bodies of water, have been noted in many species of ducks. These are all factors which are associated with reduced availability to hunters and probably with differential patterns of vulnerability between the sexes. The differences in patterns of vulnerability between the sexes within a species and between species may also produce significant bias in banding returns. Although there is still a great need for evaluating the effects of natural or non-hunting mortality on sex ratios of ducks, it seems that the sex ratios of the various species of ducks may one day be regarded as an expression of the comparative vulnerability of males and females to hunting.

The indications of basic differences in the amount of activity between male and female canvasbacks are of considerable theoretical importance. These differences may have been the original cause of imbalance between the sexes when canvasbacks were first hunted. This thought leads to the further consideration that much of the population dynamics of present day canvasbacks may be the result of hunting. One-half of the male canvasbacks do not accompany females to breeding areas and have no apparent function in reproduction. They raft up in large flocks in May and June and spend the summer on feeding and molting habitats completely away from breeding females. If these males are truly gun-produced surpluses, then there is need to carefully inspect the structure of canvasback populations as balanced systems which were generated by hunting in the past and which are maintained by differences in male and female vulnerability to hunting. This suggestion applies to other species of waterfowl as well.

SUMMARY

In September and October, 1960, 3,979 canvasbacks were observed and recorded as they responded to decoys and flew across shooting passes at Oak Lake, Dauphin Lake, and the Delta Marshes in southern Manitoba. Aerial and ground surveys, timed to match these periods of decoy and pass observations provided information on the migration, sex and age composition, and size of the canvasback populations.

The observations of canvasbacks responding to decoys indicate that the adult females and juveniles are markedly more vulnerable to hunting over decoys than are the adult male canvasbacks. Females and juveniles tend to respond to decoys by flying right in and landing or crossing low over the decoys, but the adult males tend

to circle at greater distances, and land in the decoys less often than females and/or juveniles.

Female and juvenile canvasbacks are also more vulnerable to shooting over passes than are adult males. They cross the passes lower and tend to circle over the passes more than the adult males. When adult males flew across the passes they tended to fly higher, to lead the flocks, and to cross without turning. Canvasback flocks flew across the shooting passes lower at dawn and dusk and on cloudy days.

There is a strong tendency for female and juvenile canvasbacks to occur in smaller flocks than adult males, and the birds in these smaller flocks are much more prone to shooting mortality. The canvasbacks which responded to decoys occurred in smaller flocks than those that crossed the passes.

Adult female canvasbacks appear to be more active than adult male canvasbacks. Juveniles also tend to be more active than adult males. This tendency to be more active is a factor in mortality since in hunting situations it brings the female and juvenile canvasbacks into contact with hunters more often.

There are differences in the migration of adult male canvasbacks as compared to females and juveniles, and there are corresponding differences in the patterns of vulnerability. In September the migrating canvasbacks in southern Manitoba are primarily females and juveniles, but all categories—adult males, adult females, and juveniles are more vulnerable to decoy and pass shooting than in October when the population is primarily adult males. However, in both September and October the adult females and juveniles are more vulnerable than the adult males.

Some differences in response were obtained by altering the number and color (sex) of the canvasback decoys. Canvasbacks landed in or were low over 50 decoys more than 25 decoys, and the greatest degree of change occurred in the response of adult males. Canvasbacks tended to prefer decoys of their own sex, and the males especially, landed in or flew low over male decoys more often than female decoys.

The disproportionate sex ratio of canvasbacks appears to be largely the result of differential vulnerability of the sexes to hunting. It appears that females are killed in excess of males until the population contains 60-65 per cent males and then the males are killed in greater numbers, thus the female vulnerability is balanced by the numerical abundance of males.

Selective shooting of male canvasbacks is possible. Some hunters practice selective shooting now, and in addition, male canvasbacks will respond more readily to large numbers of white (male) decoys. However, an increased harvest of canvasback males will only result in decreased canvasback populations unless females are protected from indiscriminate shooting.

Additional investigations of the behavior of canvasbacks and other species of waterfowl in hunting situations are needed. These studies should cover many migration areas and wintering habitats, and include surveys of population size, sex ratios, and the composition of hunter's bags.

ACKNOWLEDGMENTS

This study is part of a larger investigation which was sponsored by the University of Minnesota and the Delta Waterfowl Research Station. William H. Marshall, H. Albert Hochbaum and Angus Gavin served as advisors, and the Ingersol Foundation and the North American Wildlife Foundation provided financial support. A great many individuals have contributed time and interest to this study. Some known by name include: Herman Battersby, Norton Cross, Robert Gaylord, Sr., David Hatch, Robert Jacobs, Fred Maytag, Nan Mulder, Orrin Rongsted, Morton Smith, Roy Walsh, and Peter Ward, but there are many more including sportsmen who have contributed duck wings or other information. I owe a large debt of gratitude to all.

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DISCUSSION

MR. LEE SMITH (Detroit): I would just like to ask whether there is a disproportion in sex ratio—in fact, whether this is true of all other species as it is of the canvasbacks?

MR. OLSON: In general, diving ducks have more disproportionate sex ratios. than dabblers. Observations in Louisiana suggest a vulnerability pattern in lesser scaup similar to that in canvasbacks. I also think it was Harmon who, about two years ago, reported there were 4.36 males per female in offshore rafts, but in the same year, for birds examined in the hunting season, the kill was approximately one male per female. Therefore, I suspect that this same phenomenon applies to dabbling ducks, because their sex ratios are not as severely deranged.

VICE CHAIRMAN SCHONING: Are there further questions?

MR. AL GEIS: I would like to clarify one point that you made and this relates to the matter of whether the adult females had the same annual rate of mortality as the adult males. It seems rather clear that in the adult populations there was some distortion. It also seems clear that in most species the sex composition of each year's recruitment has an even sex ratio. When these two conditions are present, there, of necessity, must be a higher rate of mortality for females. I have been given the impression, from what you said that you did not feel this was the case in this species and I don't see how it can help but be otherwise.

MR. OLSON: No, I believe that there is a higher rate of mortality in the females, but I was impressed that the difference in the mortality rates between males and females was not larger in view of the great differences in vulnerability. I suspect this is due to the buffering effect of the extra males.

MR. GEIS: There is one other angle here that I would like to elaborate on and that is that your data shows a rather marked change in ratio of males to females between the two specific time periods that you showed in one of your tables. It seems to me that a component of differential vulnerability is changes in availability of birds of particular age and sex in various places.

Now, what are your interpretations of this phenomenon as you saw it in your data? It would appear that either the females left your study areas as the season progressed or the males arrived.

MR. OLSON: A differential migration does take place—females and juveniles first and then males later. Of course there are some other factors we should consider here: Because of their tendency to be distributed in small flocks and the use of very small habitats and closeness to the shoreline areas, females and juveniles tend to show up in the miscellaneous type killing that take place in many small marshes and lakes down the flyway. On the other hand, the males have a very definite preference for large bodies of water and, in general, when we go to look for canvasback population and hunting, these are the areas that we survey.

BROWSE PREFERENCES OF PRONGHORN ANTELOPE IN SOUTHWESTERN UTAH[1]

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Pronghorn antelope (*Antilocapra americana*) were historically present in Utah, and if one can judge from the frequency of early reports, they were numerous (Udy, 1953). More recently populations probably have not exceeded a few hundred or in more favorable periods a few thousand head despite the introduction in recent years of several bands. The concern over the apparent failure of antelope to increase as have other big game animals led to a study of this species on the western deserts of Utah. The results reported here represent a small part of this intensive study.

DESCRIPTION OF THE AREA

The study is centered in Pine Valley located in western Beaver and Millard counties in southwestern Utah. The area is typical of the intermountain valleys of the Great Basin Province. Soils are immature and varyingly alkaline. The vegetation is comprised of the various communities of the northern desert shrub formation (Shantz, 1925).

The valleys, such as Pine Valley represents, are grazed by livestock largely during the winter months. In some areas summer-long use by cattle is practiced. Primarily these deserts are the winter ranges for sheep.

Range conditions differ greatly from place to place. Past heavy use has greatly altered the vegetation over much of the range. Improved range and livestock management has resulted in improvement of some areas although heavy and improper seasonal use still exists and poor range conditions still are found.

Range carrying capacities are low and vary from 10-17 acres per cow per month.

ANTELOPE USED

The animals used were captured on a military reservation in western Utah. When the reservation was put under fence a few

[1]Contribution from a cooperative investigation between the Utah State Department of Fish and Game, Utah State University and Intermountain Forest and Range Experiment Station, U. S. Forest Service. The work was conducted under Federal Aid Project W-105-R.

antelope were enclosed, and the herd gradually increased. In consequence of a water supply and improved forage conditions adjacent to buildings and work areas, the animals became tolerant of human activity. Thus, they promised to be adaptable to confinement and controlled feeding.

Four males—one mature, one yearling and two fawns—and two females—one mature and one fawn—made up the experimental herd. They were confined in an area of 40 acres in a sheep and antelope proof fence at the Desert Experimental Range, a branch of the Intermountain Forest and Range Experiment Station. Shadscale (*Atriplex confertifolia*), winterfat (*Eurotia lanata*) and dry grasses, predominantly Indian ricegrass (*Oryzopsis hymenoides*) were the prominent species. Dry Russian thistle (*Salsola kali* var. *tenuifolia*) was evenly distributed over the pasture although it had attained a height of only 2 to 3 inches.

The animals were placed in the area early in October. Although they obtained some forage from the pasture, hay, livestock pellets, and native browse formed the bulk of their diet between October and mid-December when controlled feeding began. The antelope were, therefore, familiar with and accustomed to forage plants used in the experiment.

Water was available to the antelope at all times.

Methods and Procedures

Racks were constructed to hold the offered plants. Entire plants of the smaller species and branches from those of larger stature were harvested and attached to the feed racks. A preliminary forage offering was given the animals to accustom them to the setup and allay suspicion of the added racks required.

Plants were weighed prior to being attached to the racks. After 24 hours the material of all species upon which utilization had taken place were removed and reweighed. Each morning and evening the forage was examined and additional material was offered of those species which had been utilized. At no time was there a shortage of available forage of any species. Hence, the results are believed to represent antelope preferences for desert browse species at this season.

Additional material was weighed, attached to racks out of reach of animals and reweighed at the same time that the forage was removed from the racks. This provided a correction factor and accounted for accidental handling losses, such as breakage. Forage samples were clipped to determine the dry weight contents.

The data obtained represent six days of feeding.

RESULTS AND DISCUSSION

The species offered and the amounts of each species consumed are shown in Table 1.

TABLE 1. FORAGE CONSUMED BY SIX ANTELOPE DURING A SIX-DAY PERIOD.

	Consumption			Daily Digestible Nutrient Intake	
	Total		Mean Daily (grams)		
	Wet (grams)	Dry (grams)		Protein (grams)	T.D.N. (grams)
Big sagebrush (*Artemisia tridentata*)	19,619.5	11,202.7	1,867.1	136.96	1,458.2
Black sagebrush (*Artemisia nova*)	6,955.4	4,256.7	709.5	31.93	334.9
Juniper (*Juniperus osteosperma*)	7,381.8	4,074.8	679.1	6.79	431.2
Cliffrose (*Cowania stansburiana*)	959.2	568.8	94.8	3.13	44.7
Pinyon (*Pinus monophylla*)[1]	441.6	205.8	34.3	.34	21.8
Mt. mahogany (*Cercocarpus intricatus*)	146.8	91.2	15.2	.09	1.0
Fourwing saltbush (*Atriplex canescens*)	63.7	40.4	6.7	.39	2.5
Yellowbrush (*Chrysothamnus stenophyllus*)	38.4	34.7	5.8	.18	2.9
Desert almond (*Prunus fasciculata*)[1]	30.0	26.3	4.4	.14	1.3
Brigham tea (*Ephedra nevadensis*)[1]	20.6	12.8	2.1	.07	.6
Greasewood (*Sarcobatus vermiculatus*)[1]	16.8	12.8	2.1	.07	.6
Bud sagebrush (*Artemisia spinescens*)	10.7	6.8	1.1	.15	.6
Winterfat (*Eurotia lanata*)	7.8	5.5	0.9	.06	.3
Hopsage (*Grayia spinosa*)	0	0	0	0	0
Rabbitbrush (*Chrysothamnus nauseosus*)	0	0	0	0	0
Shadscale (*Atriplex confertifolia*)	0	0	0	0	0
Total			3,423.1	180.3	2,300.6

[1] No digestion coefficients available. Juniper coefficients were used for pinion. The lowest values observed were used for the remainder.

Of the 16 species fed, three received no use. Eight other species contributed slightly more than 1 percent of the total forage consumed. More than half of the total forage was contributed by big sagebrush (*Artemisia tridentata*). Five species comprised almost 99 percent of the diet.

Of particular interest is the comparative consumption of big sagebrush and black sagebrush (*A. nova*). The latter is generally regarded as more palatable to livestock than is big sagebrush. Our findings suggest that the reverse is true with antelope as it is with mule deer (Smith, 1950).

Only two references could be found in the literature that compared the importance of different species of *Artemisia* for antelope. Einarsen (1948) indicated that dwarf sagebrush (*A. arbuscula*), a species closely related to black sagebrush, was preferred to big sagebrush. Cole and Wilkins (1958) found big sagebrush to be less important in fall and more important in winter than silver sagebrush (*A. cana*) as determined by stomach samples.

Even more striking is the fact that despite the presence of cliffrose (*Cowania stansburiana*), littleleaf mountain mahogany (*Cercocarpus intricatus*), and fourwing saltbush (*Atriplex canescens*), both species of sagebrush were taken in preference to them. These findings indicate that the sagebrushes are preferred diet components rather than being merely acceptable to antelope.

Individual weights of the animals fed were not available. However some of the animals were weighed when the herd was released. From these weights and others found in literature an estimate of the gross herd weight of 450 pounds was derived. This was used to compute the consumption per hundredweight.

The consumption estimate thus obtained, 1.67 pounds per hundredweight, is lower than might be judged adequate. However, the antelope spent a considerable amount of time foraging in the enclosure. Observations indicated that Russian thistle was the plant being eaten. This would increase somewhat the total forage intake as well as the nutrient values, for Russian thistle is comparatively high in protein. No satisfactory basis for evaluating the forage obtained from this source could be devised.

Nutrient values were calculated using the consumption data found and published digestion coefficents of the plant species fed obtained with mule deer and sheep (Cook *et al.*, 1954; Smith, 1957; and Pieper *et al.*, 1959. Probably these may differ somewhat from values which might be obtained were antelope used in digestion trials, but there appear to be no great differences between the digestive capacities of different ruminants.

These calculations indicate that a diet such as is shown in these data is adequate from the standpoint of nutrition. Digestible protein made up 5.3 percent and total digestible nutrients 67 percent of the diet. These are well above the recommended levels for domestic sheep under similar range conditions, which are 4.4 percent and 46 percent respectively. (National Academy of Science—National Research Council, 1963). Even if the total digestible nutrient value is discounted in recognition of the fact that part of the ether extract fraction is composed of volatile oils, which probably are not usable, there appear to be ample nutrients available.

These findings indicate that an antelope diet composed largely of sagebrush is adequate to provide proper nutrition. Only where there is a shortage of these preferred foods would improper nutrition occur during the winter months. Lack of forage, though a possibility locally, seems not to be of general concern especially on cattle ranges. Locally, heavy use by sheep may cause a shortage in the forage supply in the late winter or early spring prior to the onset of spring growth. This shortage of forage may be partially offset by bud sagebrush (*A. spinescens*) which starts growth early in the spring, although this species seems to be less palatable to antelope than other members of the genus.

It would appear that low productivity of antelope herds in this area is not attributable to a low level of nutrition during the winter months on properly managed ranges. Inadequate succulent forage during breeding and post-fawning periods is a distinct possibility.

SUMMARY

Six antelope were fed 16 species of browse plants common on desert ranges of Utah for a period of six days. Ample amounts of all species were available so that free choice could be expressed.

Three species, big sagebrush, black sagebrush and juniper provided the major part of the diet. More than half was provided by big sagebrush.

Nutrient values of the diet were computed using digestion coefficients determined with mule deer and sheep. The values thus obtained were well in excess of accepted standards for domestic sheep.

Unless competition from livestock seriously reduces the volume of sagebrush available to antelope, a low plane of nutrition during winter does not appear to be a factor in the productivity of this species in western Utah.

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DISCUSSION

DR. CLARENCE COTTAM (Texas): Antelope occur in some places where there is no sagebrush. What do they eat under those circumstances? We know they still exist and I wonder if there is anything in relation to this? For example, quite often you will find they will take one thing in one place and then feed on the same thing in another area. In other words, is there any sort of data available relative to their feeding in the various areas?

MR. SMITH: We have been asking ourselves that question and we have not found the answer as yet.

It is of interest perhaps to elaborate on this some more. On the reservation, the reason the animals stayed there was that there was water and a considerable amount of forage material available. These animals, I think, exhibit a preference for this type of vegetation. Also, in connection with certain other data, we found them eating sagebrush at all seasons of the year. Of course, we frequently follow their tracks and observe what they eat. At no season of the year have we made such an examination but we found them eating sagebrush in this particular area.

TECHNICAL SESSION

Monday Afternoon—March 8

Chairman: WILLIAM L. JELLISON[1]
U. S. Public Health Service, Hamilton, Montana

Discussion Leader: A. M. FALLIS
Director, Department of Parasitology, Ontario Research Foundation, Toronto

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DISEASE, NUTRITION AND CONTROL

A SEROLOGICAL STUDY OF INFECTIOUS DISEASES OF WILD POPULATIONS IN SOUTH TEXAS[2]

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University of Wisconsin, Madison

W. C. GLAZENER
Welder Wildlife Foundation, Sinton, Texas, and

B. D. NASSIF
University of Wisconsin, Madison

Information concerning diseases of wild populations has usually been acquired in one of the following ways: first, morbidity or mortality reports from zoos and/or parks describe some of the diseases of wild animals in captivity (Proceedings of the Zoological Society, London; Zoologica, New York). Second, spectacular die-offs of wild populations are sometimes observed and investigated, (Quortrup and Shillinger, 1941; Bellrose, 1959; and Shope *et al.*, 1960). Third, serologic and parasitologic surveys are sporadically conducted on easily sampled wild populations, often as a by-product of a human or livestock disease problem (Wood, 1954; McKeever *et al.*, 1958; Karstad *et al.*, 1960). All of these approaches add to our

[1]In the absence of the chairman, Dr. Fallis presided and Dr. Carlton Herman assumed the duties of discussion leader.
[2]This study was supported in part with grant funds from the Welder Wildlife Foundation. Published as paper NS 458 from the Department of Veterinary Science, University of Wisconsin.

sparse knowledge of the subject, but none go to the heart of the problem, the significance of disease in wild populations.

The objectives of this study are to: first, determine the presence and prevalence of specific diseases in selected wild populations on the Welder Wildlife Refuge, and second, evaluate the significance of specific diseases to these wild populations. To accomplish these objectives, a broad serologic study of selected wild populations found on the Refuge was initiated. This paper presents the preliminary results of this serologic approach.

DESCRIPTION OF STUDY AREA

The study area is the Welder Wildlife Refuge located on the southern Gulf Coast of Texas. This 7800-acre refuge is 7 miles long by 0.3 to 2.6 miles wide and lies in a transitional zone between the vegetational regions of the Coastal Prairie and the Rio Grande plain (Gould 1957). Consequently, both the flora and fauna are quite diversified as a result of the intermixed vegetational types (Box 1961). The Refuge has a long history of livestock use and at present approximately 500 head of cattle graze the area. The land has never been tilled except for a small amount of mechanical brush control.

The Refuge supports substantial numbers of wild birds and mammals including a white-tailed deer (*Odocoileus virginianus*) population estimated at 90 to 100 deer per square mile, good populations of quail (*Colinus virginianus*), wild turkey (*Meleagris gallopavo*), cottontail rabbits (*Sylvilagus floridanus*), and a variety of other species found in lesser numbers.

METHODS

Wild animals were collected on the Refuge utilizing a variety of methods. Whole blood was collected and blood smears made from each of these animals. The whole blood was allowed to clot, the serum removed and immediately frozen. It was then shipped to the University of Wisconsin on dry ice via air express where it was held at -20°C pending testing. Blood smears were air dried, fixed in alcohol, stained with Giemsa stain, and examined microscopically using oil immersion.

Since deer were one of the major wild populations on the Refuge, this species received special consideration. Sixty deer were collected by shooting 15 every 3 months to obtain a seasonal distribution of samples. During the fall and winter additional deer were live trapped as part of a movement and tagging study. These animals were bled from the jugular vein using 20 ml vacutainers. Young fawns, 1 to 2 hours to 14 days of age, were sampled in conjunction with a fawn tagging program. These fawns were caught by hand and bled from the jugular vein with 10 ml vacutainers.

Other small animals collected during this study were either shot or live trapped and bled.

During the summer of 1964, four pairs of domestic rabbits (one black and one white) and four pairs of white Plymouth Rock chickens were employed at four different locations on the Refuge as sentinels to detect possible activity of arthropod-borne diseases. One-half inch, open mesh, wire cages were used to house these sentinels. They were bled prior to exposure on the Refuge and then at 10-15 day intervals.

Prior to serologic testing, all serums were heat inactivated at 56°C for 30 minutes. Samples were screened for the presence of selected virus neutralizing antibodies in the HeLa cell metabolic inhibition (MI) test (Kuns, 1962). Virus antibody tested for in this system included: eastern (EEV), western (WEV), California (CEV), St. Louis (SLEV) and Venezuelan (VEV) encephalitis viruses, as well as encephalomyocarditis (EMC), and vesicular stomatitis virus (VSV), both the New Jersey (VS-NJ) and Indiana strains (VS-I).

The slide agglutinin test (Difco Co., Detroit, Mich.) was employed in the tularemia serologic screening.

Serums of 40 adult deer were tested serologically for antibodies of anaplasmosis and piroplasmosis by Dr. Miodrag Ristic, Department of Veterinary Pathology, University of Illinois. A capillary tube agglutination test was used for anaplasmosis and a precipitation test in gel for piroplasmosis (Ristic, 1964, personal communication).

Selected serum samples were tested for agglutinins to seven serotypes of leptospirosis using live antigen procedures as approved by the U. S. Livestock Sanitary Association (1960). Serotypes utilized included: *L. pomona, L. icterohaemorrhagiae, L. canicola, L. hardjo, L. autumnalis, L. hebdomadis,* and *L. grippotyphosa.* Brucellosis was tested for utilizing the serum plate agglutination procedure (U.S.D.A., 1950). These tests were conducted at the Wisconsin Department of Agriculture, Central Animal Health Laboratory, Madison.

To complement the leptospirosis serology, attempts to isolate leptospires were made from 15 deer collected during the summer of 1964. Individual kidney tissue and urine samples were cultured in Stuart's and Fletcher's media utilizing procedures described by Galton *et al.*, (1962). The pH of surface waters at various locations throughout the Refuge was tested with a Beckman 180 Pocket pH Meter.

RESULTS

Virus: Sixty-nine adult deer (1 year of age or older) and 70 fawns (2 weeks of age or less) were bled during 1963; 39 adults and 95 fawns during 1964. The largest number of serologic reactors in both age classes of deer was against California encephalitis virus (CEV). In 1963, 70 percent of the adult deer and 84 percent of the fawns were CEV reactors; 38 percent of the adults and 89 percent of the fawns reacted to this virus in 1964 (Table 1).

TABLE 1. VIRAL SEROLOGIC REACTORS AMONG SELECTED WILD POPULATIONS

Species[1]	Age[2]	Sampling Period	Sample Size	Percentage of Reactors[3]							
				EEV	WEV	CEV	SLEV	VEV	EMC	NJ	IND
Deer	A	Winter '63	17	0	0	59	6	0	0	0	0
Deer	A	Spring '63	29	0	10	90	7	0	0	7	0
Deer	F	Summer '63	70	0	19	84	0	2	–	13	3
Deer	A	Fall '63	23	0	0	50	4	0	–	0	0
Deer	A	Winter '64	15	0	13	0	0	0	–	0	0
Deer	A	Spring '64	15	0	7	67	0	0	–	–	–
Deer	A	Summer '64	9	0	0	56	0	0	–	0	0
Deer	F	Summer '64	95	0	7	89	3	26	–	1	16
Rabbit		1963–64	16	0	19	6	25	0	–	12	0
Raccoon		1963–64	5	0	0	20	60	–	–	–	–
Turtle		1964	1	0	0	0	0	0	–	100	0

[1] Deer, all white-tailed; rabbit, conttontail; turtle, soft shelled.
[2] A indicates adults one year of age or older; F indicates fawns two weeks of age or less (deer only).
[3] (–) indicates tests not conducted.

The serologic test detected a small number of reactors among deer to SLEV, WEV, VEV, and VSV. No serologic reactors to EEV or EMC were encountered in the deer tested.

Wildlife other than deer that were bled during 1963 and 1964 and had viral antibodies (Table 1) were cottontail rabbits (CEV, WEV, SLEV, and VSV-NJ), raccoon (*Procyon lotor*) (CEV and SLEV) and a soft-shelled turtle (*Trionyx spinifer*) (VSV-NJ). Miscellaneous species tested in which no reactors were detected included 6 rattlesnakes (*Crotalus atrox*), 1 bullsnake (*Pituophis melanleucas*), 3 coachwhip snakes (*Masticophis flagellum*), 1 turkey vulture (*Cathartes amura*), 2 black vultures (*Coragyps atratus*), 3 plains packrats (*Neotoma micropus*), 1 pocket gopher (*Geomys bursarius*), 2 opossum (*Didelphis marsupialis*), and 2 armadillo (*Dasypus novemcinctus*).

Serologic testing of 17 staff and students at the Refuge in January, 1964, revealed antibody activity for St. Louis encephalitis virus in two individuals (12 percent).

Deer collected in the two western pastures of the Refuge, Moody and Lake, were compared to those collected in the two eastern pastures, Calaboose and Mare Trap (Table 2). Only those viruses to which reactors were demonstrated are listed. The Chi Square test was used to detect significant differences in the data. The number of adult female CEV reactors in Moody-Lake pastures was significantly larger (99 percent level) than the number of reactors in the Calaboose-Mare Trap pastures. This difference dropped to the 95 percent level when males and females were combined and compared. A significant difference (99 percent level) existed between male and female CEV reactors in Moody-Lake pastures and also between male and female CEV reactors when all four pastures were combined. No other significant geographic or sex differences were detected.

When the percentage of adult CEV reactors during the four seasons of the year (winter, spring, summer and fall) were compared there was a definite seasonal variation (Figure 1). Peak antibody detection occurred in spring. A similar seasonal variation was observed for leptospirosis.

Serologic results of the rabbit and chicken sentinels on the Refuge showed activity of CEV (2 conversions), VEV (2 conversions), and WEV (1 conversion). The conversions all occurred in July following a 9-inch rainfall which resulted in a noticeable increase in arthropod numbers and activity.

Bacteria and Protozoa: Results of serologic tests against various bacterial and protozoan agents are presented in Table 3. Serologic reactors to leptospirosis and tularemia were detected, but only leptospirosis reactors were present in significant numbers. Forty-one (61 percent) of the deer serums reacted to one or more of the seven serotypes used. The most active serotype was *L. autumnalis*. Twenty-five deer (37 percent) reacted to this serotype alone or in various combinations with the other six. *Leptospira hardjo* was the next most common serotype present (26 percent). Eight of the deer (12 percent) showed *L. pomona* activity, a serotype known to be important in cattle.

The pH of surface waters tested during June, July and August (26 samples) were as follows: Aransas River, average pH 8.0; earthern water storage tanks and lakes 8.1; and surface pools after rain 7.6. All water sources sampled tested on the alkaline side. Attempts to isolate leptospires from 15 white-tailed deer were unsuccessful.

Forty deer serums tested for antibody against anaplasmosis and piroplasmosis were all negative.

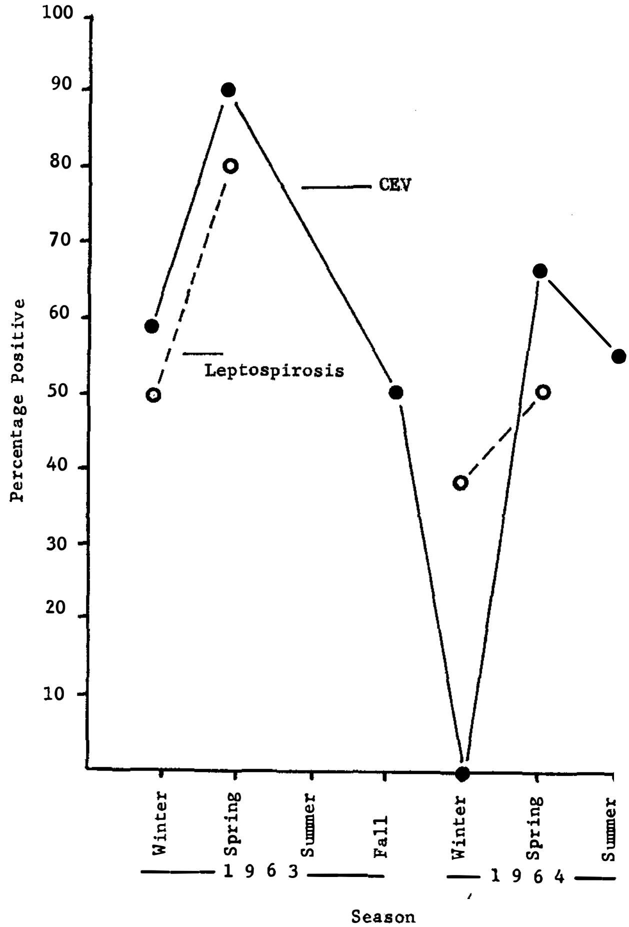

Figure 1. Seasonal variation in the percentage of reactors to CEV and Leptospirosis in adult deer.

DISCUSSION

The specificity and sensitivity of the metabolic inhibition test, to the eight viruses used in this study, have not been completely evaluated. In those instances where results have been compared quantitatively with other established serologic procedures the specificity has been very good; CEV, (Thompson, 1964), EEV (Yuill, 1963) and VSV (Castaneda, 1965). The MI test was less sensitive than conventional neutralization tests in detecting antibody to VSV and EEV (Castaneda, 1965; Kuns, 1962). The significance of positive reactions in the MI test for viruses that have not been comparatively studied is open to question. The usefulness of the test in defining areas for futher serologic study is unquestionable.

The serologic results of both the wild populations and sentinels indicated that several virus diseases were active on the Welder Refuge. Of the eight agents used in the MI screening test, only EEV and EMC failed to have any reactors.

California encephalitis virus appears to be the most active of the viruses tested, particularly in the deer population (Table 1). Of the adult deer tested 60 percent had neutralizing antibody; among the fawns tested 87 percent were reactors.

This high fawn reactor rate does not necessarily reflect greater activity of CEV in the fawn population. Since these fawns were two weeks of age or less any antibody they possessed was undoubtedly transmitted from their mother. The number of fawn reactors therefore, more accurately reflected the activity of CEV in the entire deer herd. The higher percentage of fawn CEV reactors than adult reactors may be the result of concentration of maternal antibody in the colostrum of the mother (Blakemore, 1959) which was then passively transferred to the offspring by ingestion (Smith *et al.*, 1964). The serum antibody titer of the mother might be too low to be detected in the MI test; yet antibody could be concentrated in the fawn, via colostrum consumption, in sufficient amount to be detectable in its serum.

Two fawns born in 1964 and raised in captivity on the Refuge reacted to VEV at two weeks of age. Their mother, a two year old doe that had been raised in captivity, did not have detectable antibody to VEV or any other viral agent used in these tests. This further suggests possible concentration of maternal antibody in colostrum.

Two fawns, less than two weeks of age, were captured during the summer of 1963, and were CEV reactors. At six months of age these fawns were no longer CEV reactors, suggesting that this passive CEV antibody is of short duration.

A marked seasonal variation in the percentages of CEV reactors in adult deer exists (Figure 1). If, as suspected, CEV antibody is of short duration it helps explain this seasonal variation. The season of greatest virus activity, spring, coincides with the seasonal peak of arthropod abundance. Arthropods are considered the chief vector of CEV; therefore, the simultaneous peaks of serologic reactors in the deer population and the insect populations is not surprising. It might well be that neutralizing antibody, although present in deer during the winter months, is at a level too low to be detected by the test used. Spring produces an explosion of arthropod vectors and virus transmissions which result in an immunological amnestic response in the deer.

Laboratory studies on the persistence of CEV antibody in deer are now underway at the University of Wisconsin.

The importance of CEV to wildlife populations is for the most part unknown; however, it is generally not considered to be detrimental. This conclusion may change as more information is compiled on this virus, just as its importance to humans has been recently altered (Thompson *et al.*, 1965). The geographic as well as the host range of this virus, or virus complex, has expanded rapidly in recent years due to the accumulation of new information. It is now known to be present over much of North America. Additional surveys for this virus will undoubtedly expand its ranges even more.

From these studies it appears that deer populations are very sensitive to yearly variation in CEV activity and can be quite valuable as an indicator species for the activity of this virus. Aside from deer, only one cottontail rabbit and one raccoon reacted to CEV.

TABLE 2. THE SEROLOGIC RESULTS OF ADULT WHITE-TAILED DEER COMPARED ON THE BASIS OF SEX AND GEOGRAPHIC LOCATION

SEX	WEV		CEV		SLEV		VSV-NJ	
	M-L[1]	C-MT[1]	M-L	C-MT	M-L	C-MT	M-L	C-MT
Male	0/9[2]	0/6	2/9(22)	2/6(33)	0/9	0/6	0/9	0/6
Female	3/37(8)	3/18(17)	39/47(83)	8/18(4)	2/47(4)	1/18(6)	1/47(2)	1/18(6)
Total	3/56(5)	3/24(12)	41/56(73)	10/24(42)	2/56(4)	1/24(4)	1/56(2)	1/24(4)

[1] M-L = Moody-Lake pastures; C-MT—Calaboose-Mare Trap pastures.
[2] No. positive (numerator); No. sampled (denoninator); and ( ) = percent positive.

St. Louis encephalitis virus, an important zoonosis in Texas, was present in low percentages of the wild populations sampled (Table 1). A serious epidemic of SLE occurred in humans in the Houston area, 200 miles north of the Refuge, during the late summer of 1964. Two previous outbreaks of this disease have also occurred in Texas, one in Hidalgo County in 1954 and the other in Cameron County in 1957 (Sullivan *et al.*, 1959).

Of potential significance was the finding that 26 percent of the 1964 fawn crop reacted to VEV. During the summer of 1963 only one fawn out of 70 tested reacted. The sharp increase in the percentage of VEV reactors in 1964 as compared to 1963 indicates increased activity of the VE virus or a related virus in the area. VEV was isolated 500 miles to the south at Veracruz, Mexico, in

1963 (Scherer *et al.,* 1964) and was also detected in the Florida Everglades by Work (1964) and Chamberlain *et al.,* (1964). The fact that the VEV reactors did not have antibodies to other Group A viruses (EEV and WEV) suggests that the reactive substances may be specific. These sera are presently being tested by Dr. P. H. Coleman at the U.S.P.H. Communicable Disease Center Laboratory, Atlanta, Ga.

TABLE 3. BACTERIAL AND PROTOZOAN SEROLOGIC REACTORS AMONG SELECTED WILD POPULATIONS

Species[1]	Age[2]	Sampling Period	Disease Agents				
			Leptospira	Tularemia	Brucella	Anaplasma	Piroplasma
Deer	A	Winter '63	9/18 (50)[3]	——	0/10	0/5	0/5
Deer	A	Spring '63	24/30 (80)	——	0/10	0/5	0/5
Deer	F	Summer '63	——	1/7	——	——	——
Deer	A	Fall '63	——	——	0/8	0/15	0/15
Deer	A	Winter '64	5/13 (38)	——	0/10	0/15	0/15
Deer	A	Spring '64	3/6 (50)	0/14	0/10	——	——
Deer	A	Summer '64	——	0/13	0/8	——	——
Deer	F	Summer '64	——	7/70	——	——	——
Deer	A	Fall '64	——	0/10	0/10	——	——
Deer	A	Winter '64	——	——	0/10	——	——
Rabbit		1963–64	——	0/6	——	——	——
Armadillo		Jan '64	——	0/2	——	——	——

[1] Deer, all white-tailed deer; rabbit, cottontail; armadillo, nine-banded.
[2] A indicates adults one year of age or older; F indicates fawns two weeks of age or less.
[3] No. positive (numerator); No. sampled (denoninator); ( ) = percent positive.

White-tailed deer, cottontail rabbits and a soft-shelled turtle reacted to VSV (Table 1). Among deer, most of the reactors were fawns which reacted to both the New Jersey and Indiana strains. Only two adult deer were VSV reactors, both to the New Jersey strain. The finding of VSV antibody in deer, especially the NJ strain, is consistent with other reports in the literature (Karstad *et al.,* 1956). An epizootic of VSV-I occurred in cattle in Texas during 1964 (U.S.D.A. Report 2658, 1964). This virus was also active among fawns in the Refuge during this period.

Based on serologic evidence leptospirosis appears to be quite prevalent in the Refuge deer population (61 percent). This is compatible with other reports that a wide variety of wildlife have antibody to leptospires, especially deer (Roth, 1964). Some of the reasons for the high percentage of reactors in this deer population might be: 1) the high population of approximately 100 deer per square mile which provides close physical association; 2) prolonged dry periods which result in the elimination of surface pools, forcing deer to congregate and drink at a few earthen water storage tanks; and 3) during periods of rain the appearance and persistence of surface pools provides a water source for deer to deer, as well as deer to cattle contact.

The average pH values of waters used for drinking ranged from 7.6 to 8.1 and potentially provides optimal conditions for leptospire survival and transmission.

The high prevalence of *L. autumnalis* and the minimum detection of *L. pomona* in the deer population is interesting. These results vary considerably from serologic findings of others (Trainer *et al.*, 1963, Adbulla *et al.*, 1963, Ferris *et al.*, 1961).

It appeared that a seasonal variation in the percentage of leptospirosis reactors in adult deer occurred (Fig. 1). The increased percentage of reactors from winter to spring is similar to that observed for CEV. These apparently similar seasonal patterns of two entirely different types of disease at the same season of the year illustrate the similar, yet different role of environment in their life history. Spring rainfall may be the significant factor. With CEV it results in an increase of arthropod vectors and the spread of virus; for leptospirosis it creates more surface water pools which may aid the spread of the infectious agent. Additional testing of deer at all seasons of the year may help clarify the seasonal incidence of the latter disease.

The lack of brucellosis reactors in deer supports the findings of other investigators as summarized by Fay (1961). The lack of reactors among the cottontail rabbits to tularemia, a species highly susceptible to this disease, was of interest.

The failure to detect deer with antibody to anaplasmosis or piroplasmosis was further substantiated by failure to find either of these protozoans in blood smears. A *Theileria* sp. has been found in a Refuge deer by Dr. N. D. Levine (personal communication, 1963). Dr. R. M. Robinson (personal communication, 1964) found a high percentage of deer in central Texas carrying a hemoprotozoan parasite resembling *Theileria*; during this investigation, the microscopic examination of 200 slides of deer blood has not resulted in its detection.

Although the bulk of the data and discussion has concerned deer some of the initial findings in other species such as the relatively high percentage of reactors to WEV and SLEV in the cottontail rabbit population, and to SLEV in the raccoons sampled provide clues that suggest the desirability of broadening the survey to include larger numbers of other animals. Although a wide variety of wildlife species mentioned earlier did not have detectable neutralizing antibodies to any of the viral agents tested in this study, the small sample size does not permit any final conclusions to be drawn regarding either the disease or the population involved.

The white-tailed deer population received major emphasis in the study for a number of reasons: first, it is an easily accessible herd of high density; second, deer are an important natural resource on the Refuge; third, a number of intensive studies are presently being conducted on this deer herd including population density, behavior, sex and age ratios, productivity, and physiology.

Other wild populations as well as domestic animals on the Refuge, including more than 500 beef cattle and horses, are also being tested periodically in order to assess any possible inter-relationship between these animal populations.

The objectives set forth in this study were to detect the diseases present in wild populations on the Refuge and to evaluate their significance. The serologic results reported here are the first phase in fullfilling these aims.

Data accumulated over several years are needed to establish the significance of disease. This is no different than the necessity of such a time-schedule to evaluate a population structure or behavior pattern in a population. To determine the significance of disease or any other factors in a wild population, an intensive, unified, many disciplined study of the population over a sufficient period of time is essential. With this approach in mind, as well as the integrated use of planned exposures of infectious agents to wild animals under controlled conditions, it is planned to establish the significance of some of the prevalent diseases in wild populations on the Refuge.

SUMMARY

A serologic study of some wild populations on the Welder Wildlife Refuge in south Texas was conducted. The purpose was to determine the prevalence of disease in the populations and to establish a base line from which an evaluation of the significance of those diseases present could be made. This report is concerned with the serologic evaluation of disease prevalence.

The metabolic inhibition test (MI) was used to screen all serums for reactors to eight viral agents: eastern (EEV), western (WEV), California (CEV), St. Louis (SLEV), and Venezuelan (VEV) encephalitis viruses, encephalomyocarditis (EMC), and vesicular stomatitis (VSV), both the New Jersey (VS-NJ) and Indiana (VS-I) strains.

In 1963, 70 percent of the adult deer and 84 percent of the fawns reacted to the test for CEV antibodies; in 1964 38 percent of

the adults and 89 percent of the fawns reacted. Relatively few deer reacted to WEV, SLEV, VEV, or VSV.

Deer reactors to CEV showed a marked seasonal variation with peak numbers occurring in the spring and decline in winter. This suggests an antibody of short duration which would make deer valuable as indicators of CEV activity. Laboratory studies concerning the persistence of CEV antibody are now underway at the University of Wisconsin.

Twenty-five of 90 fawns (26 percent) reacted to VEV during the summer of 1964 when screened in the MI test. These results have not been confirmed with complimentary tests.

Four of 16 cottontail rabbits and 3 of 5 raccoons reacted to SLEV, an important zoonose in Texas, during the summer of 1964. Two of the 17 Refuge staff were also positive for SLEV. No animals reacted to EEV or EMC.

Bacterial and protozoan diseases for which tests were conducted included seven serotypes of leptospirosis (*L. autumnalis, L. hardjo, L. canicola, L. pomona, L. icterohaemorrhagiae, L. hebdomadis,* and *L. grippotyphosa*), brucellosis, tularemia, anaplasmosis, and piroplasmosis.

Forty-one of 67 adult deer reacted to one or more of the seven serotypes of leptospirosis. *Leptospira autumnalis* was most active with 37 percent reactors, *L. hardjo* second with 26 percent. Attempts to isolate leptospires from deer kidney tissue and urine were unsuccessful.

Tularemia reactors occurred only in the fawns of 1963 (14 percent) and 1964 (10 percent). None of the animals tested was positive for Brucella, Anaplasma, or Piroplasma.

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DISCUSSION

DISCUSSION LEADER HERMAN: This was a very interesting presentation in view of the advances being made in studies on arthropod-borne viruses particularly, and it is a type of study which is going on at levels both above and below this effort in various other parts of this country and in fact the whole world.

Concurrently with these studies are any studies of a similar nature being made in relation to what is present in the horses and cattle on the refuge and also are any concurrent studies being made of potential arthropod vectors:

MR. COOK: The answer is yes to both. We are sampling cattle and horse populations on the refuge periodically, twice a year, and we are also collecting insects in an attempt to isolate the viral agents.

CHAIRMAN FALLIS: Does the presence of antibodies of some of these Leptospira necessarily indicate that the species are pathogenic to deer?

MR. COOK: No, it does not. It means that the antibodies are there. Most studies have shown, I believe, it is not too significant to the deer population.

DR. FRANK HAYS [University of Georgia]: Dr. Cook, do the cattle in the area have antibodies to anaplasmosis or piroplasmosis?

MR. COOK: We have not tested any cattle serum serologically. We have looked through some of the slides and have not found any organisms in the red blood cells.

DR. HAYS: There is not any mortality ascribed to it?

MR. COOK: No, sir, not to my knowledge.

DR. YUILL [Walter Reed Army Institute of Research, Washington, D. C.]: What are the titers developed in the California encephalitis virus?

MR. COOK: These haven't been titered yet.

MR. N. J. MARCHETTE [San Francisco, Calif.]: I was interested to know if you have done anything with ticks, and if not, why not? These, I think, are an important vector in that area and also, have you or do you intend to do rickettsial studies?

MR. COOK: To the first question, we collect ectoparasites, anything that we can find when we handle these animals. Ticks have been collected and are being processed now for virus isolation. We have not planned rickettsial operations at this time.

DISCUSSION LEADER HERMAN: We have time for one more question.

DR. OLSON [University of Utah]: I was interested to find someone else finding tularemia bodies in deer. There seems to be a decided lack of this in the literature. On the basis of around 200 samples, we find 10 per cent in the deer. This is not too unusual since we find a high instance in the cattle in the same area. I was wondering if anybody else had any unpublished results as to tularemia bodies in the deer?

DISCUSSION LEADER HERMAN: As I remember Mr. Cook's chart, that would be within the same range, wouldn't it, one in seven and seven out of 70, so it is within about 10 per cent here also.

CEREBROSPINAL NEMATODIASIS (PNEUMOSTRONGYLUS TENUIS) IN NORTH AMERICAN CERVIDS

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A considerable body of information has accumulated on *Pneumostrongylus tenuis,* the so-called meningeal nematode of white-tailed deer, and it now seems appropriate that a general review for specialists in wildlife should be given especially as this helminth is probably a cause of neurologic disease in moose and sheep.

NOMENCLATURE

Some confusion exists in the literature as to the correct name to apply to the meningeal worm of white-tailed deer. There is now general agreement, however, that the parasite is identical to that described by Dougherty (1945) as *Pneumostrongylus tenuis.* Shulz (1951) made *tenuis* type of the monotypic genus *Odocoileostrongylus.* Unfortunately, the relationship of this genus to *Parelaphostrongylus odocoilei* of *Odocoileus hemionus* of the west coast is obscure. We suspect both *tenuis* and *odocoilei* belong in the same genus in which case *Odocoileostrongylus* would fall into the synonymy of *Parelaphostrongylus.* This question cannot be settled until new material of *P. odocoilei* has been studied. For this reason we prefer to use the name first given to this helminth. Experts on the metastrongyles are agreed, moreover, that neither *tenuis* nor *odocoilei* belong in *Elaphostrongylus* which, as far as is known at present, is found only in Eurasian cervids. Possibly there are at least two closely related species of the Elaphostrongylinae characteristic of the new world genus *Odocoileus,* one on the west coast in mule deer, the other in eastern North America in white-tailed deer. It is hoped studies of *P. odocoilei* in deer of the west coast will settle this troublesome question. The following names have been applied to the meningeal worm of white-tailed deer: *Pneumostrongylus tenuis* Dougherty, 1945; *Odocoileostrongylus tenuis* (Dougherty) Shulz, 1951; *Elaphostrongylus odocoilei* Anderson, 1956 (not Hobmaier & Hobmaier, 1934); *Neurofilaria cornellensis* Whitlock, 1952 (in sheep); *Elaphostrongylus tenuis* (Dougherty), Whitlock, 1959.

DISTRIBUTION

P. tenuis has a wide distribution in white-tailed deer in eastern North America having been found in deer in New York, Michigan, Ontario, Pennsylvania, Georgia, Minnesota, Nova Scotia, and New Brunswick. In places where it has been found the incidence of infection is remarkably high. Alibasoglu *et al.,* for example, found *P. tenuis* in the cranium of 60 of 80 deer examined in Pennsylvania. Worms were found in the cranium of 41 percent of 172 adult deer examined in Algonquin Park, Ontario but a much higher percentage of deer were passing first-stage larvae in their droppings. It is now known that mature worms occur also in the spinal subdural spaces and cranial venous sinuses where they are readily overlooked during autopsies. Probably a high incidence of the parasite occurs everywhere in eastern North America where white-tailed deer exist in abundance. The distribution of the parasite in the Midwest should be determined by parasitologists and wildlife specialists in these areas.

TRANSMISSION AND DEVELOPMENT

The main outlines of the life cycle of *P. tenuis* have been elucidated experimentally in Ontario. Adult worms are usually found in the subdural space, especially of the cranium, but cranial venous sinuses are possibly more important definitive locations especially in long-standing infections. Worms deposit undeveloped eggs on the dura mater and these embryonate, hatch; and larvae, entering small blood vessels near egg masses, are carried to the lungs where they break out into alveoli. Eggs deposited directly into the blood stream are carried to the lungs in great numbers where they form minute, scattered embolisms that become fibrosed. These encapsulated eggs develop and larvae break out of cysts and enter alveoli. First-stage larvae pass up the respiratory tract, are swallowed, and eliminated in the faeces.

In Algonquin Park the following terrestrial mollusks are suitable experimental intermediate hosts, the larvae penetrating into, and developing in, the foot: *Discus cronkhitei, Zonitoides arboreus, Deroceras gracile, Stenotrema fraternum, Triodopsis albolabris,* and *Anguispira alternata.* An aquatic *Lymnea* sp. in Algonquin Park is also a possible intermediate host, although probably a poor one. It can be seen, therefore, that *P. tenuis is* capable of developing to the infective stage in a wide range of mollusks. Field studies have not yet been done to evaluate the importance of these species in natural transmission although all are common in areas frequented by deer.

Deer presumably become infected when they accidentally ingest infected mollusks with their food. It is not known at what times of the year transmission is most likely to occur although it is reasonable to suppose it would be especially likely during periods when deer graze or feed on the ground. We have examined a five-month-old fawn that was infected and noticed repeatedly the tendency of fawns to eat dirt and leaf litter even in the presence of ample browse.

Possibly, therefore, many animals become infected in the first few months of their lives.

A remarkable feature of the life cycle is the fact that the early development of *P. tenuis* in deer takes place in the parenchyma of the spinal cord—mainly in dorsal horns. The medulla oblongata is sometimes invaded but rarely other regions of the brain. By 40 days, however, worms leave the parenchyma and move into the spinal subdural space where they mature. They tend to accumulate thereafter in the cranial region and they may penetrate the cranial dura mater and enter the intercavernous sinus behind the pituitary fossa. Infected fawns start to pass larvae 82-91 days after infection.

PATHOGENESIS

There are two major sites in white-tailed deer where important pathological changes occur in infections with *P. tenuis,* namely, the lungs and the central nervous system.

Lungs: In heavily infected animals almost every section of the lung contains minute, scattered nodules with one to three eggs in all stages of development. The scattered distribution of nodules indicates that eggs arrive via the blood stream and sometimes it is possible to find clear-cut embolisms caused by unsegmented eggs. Tissue surrounding eggs rapidly becomes fibrosed and collateral vessels are formed. Lymphocytes are frequently common near developing eggs and eosinophils may be common especially near advanced eggs or larvae that have hatched from them. Foreign body giant cells are usually formed about the remains of egg capsules. Lung tissue can be altered considerably in heavily infected regions of the lung. Collapse of alveoli and fibrosis of tissue can lead to consolidation of small but numerous and widely distributed areas. The histological picture is similar to the interstitial pneumonia in white-tailed deer attributed to *Leptostrongylus alpenae.*

Central Nervous System: One of the most surprising aspects of the infection in the parenchyma of the spinal cord is the relative dearth of histopathologic findings. Worms tend to lie in the dorsal horns longitudinally to the cord in cell-free tunnels surrounded by compressed and flattened neural tissue. Fibrosis is rarely observed. Hemorrhages are scarce, minute, and confined to grey matter. Small foreign body reactions about remains of worms or their products are sometimes observed. Cuffing with eosinophils and lymphocytes is fairly common although rare in the immediate vicinity of worms. Neuron degeneration, malacia, and microcavitation are rare or absent. Scattered swollen axis cylinders and degenerating myelin sheaths are commonly observed especially in dorsal and lateral funiculi and occasionally tiny disrupted areas in the white matter are observed. Slight to moderate cellular infiltrations, consisting mainly of eosinophils, lymphocytes, and plasma cells are sometimes found in the pia mater, especially near dorsal nerve roots. Slight infiltrations sometimes extend into the dorsal sulcus and ventral fissure, and around vessels radiating into the funiculi from the pia mater. Infiltrations become more pronounced in and on the dura mater, the epineurium, and tissues of the epidural space after 30 days and are associated presumably with the migration of worms into the subdural space. After worms leave the nerve tissue the latter rather rapidly regains a normal appearance.

Mature worms frequently deposit masses of eggs on the spinal and especially the cranial dura mater. Adults frequently burrow into the dura especially of the cranium. Associated with the presence of adult worms, developing eggs, and free larvae are chronic inflammation, minor haemorrhages caused by trauma, focal necrosis, and dense infiltrations of lymphocytes, eosinophils, macrophages, and plasma cells. The normal structure of the dura may be considerably obscured. In some infections, however, the inner surface of the cranial dura may appear normal and in these areas worms should be sought in the intercavernous sinus. In this sinus, clumps of worms can sometimes be found associated with granulomatous tissue containing innumerable eggs and larvae. Worms are sometimes found in the subarachnoid space of the brain and some may be pressing into the brain tissue; this may often be a post-mortem phenomenon, however. In our experience worms in the subarachnoid space are frequently moribund or dead. Eggs and larvae may be found on, and in, the pia mater and about the choroid plexus. Small vessels in the pia mater may contain eggs and larvae.

Clinical Signs: We have infected experimentally 13 two to three week-old fawns with as many as 500 infective larvae. In only two did we note unmistakable neurologic signs and these were minor and transitory consisting of lethargy and lameness as well as slight but regular spasms of one front limb. Caution should be used therefore in attributing neurologic signs in wild deer to infections with *P. tenuis* unless there is irrefutable histopathological evidence. The mere presence of a few worms in the cranium is not suitable evidence that clinical signs are caused by *P. tenuis*, especially as the subdural space of many white-tailed deer not showing neurologic signs harbour parasites.

P. TENUIS AND NEUROLOGIC DISEASE OF MOOSE

Moose neurologic disease is a common and widespread phenomenon on the southern fringe of moose distribution in continental eastern North America having been reported in Minnesota, southern Ontario, southern Quebec, Maine, New Brunswick, and Nova Scotia. The disease is characterized by locomotor ataxia, general and lumbar weakness, apparent deafness and blindness or impaired vision, fearlessness, listlessness, circling (often associated with peculiar positions of the head and neck), and paraplegia. It is found in moose of all age groups at all periods of the year. Emaciation and tick infestation are sometimes associated with the disease but are clearly not primary causes. Although sick animals may have trouble feeding because of paresis, neither anorexia, nor digestive and respiratory abnormalities can be considered characteristic. Body temperature is usually normal barring complicating factors. Death often follows paraplegia which may be considered as a frequent terminal stage of the disorder.

There have been a number of attempts to account for moose disease ranging from tick infestation, bacteria, viruses, toxic substances, and dietary deficiencies. None of these has adequately explained the variety of signs or the distribution of the disease and none has had sound experimental evidence.

In 1963 we first reported the results of infecting moose calves experimentally with *P. tenuis*. Both calves became lethargic 2-3 weeks after infection. Slight weakness and ataxia of the hind limbs became evident a day or two later and these signs became progressively more pronounced. The forelimbs became lame and stiff. After about five weeks both calves had difficulty rising and would frequently collapse in the attempt. There were peculiar remissions of short duration and the signs shifted sometimes from limb to limb. The animals walked as though the front limbs were hobbled and the hind limbs aften bowed out markedly. A slight push on the hind quarters would cause the animals to stumble to one side. The calves stood for long periods in the same position with the head low, the hind limbs widely spaced, the bulk of the weight being taken by the front limbs. On the 39th day the right hind limb of one calf became paralysed. On the 48th day the left hind limb of the other calf became paralysed and on the 50th day its head and neck were constantly twisted towards the left. There was neither anorexia, nor digestive and respiratory abnormalities, and the body temperature remained normal. The similarities of the signs observed to those noted by numerous authors in wild moose was striking.

One calf was autopsied on the 40th day and the other on the 60th day following infection. Numerous *P. tenuis* were found in subdural spaces, especially of the spinal cord, of both calves. More significant, however, was the discovery of numerous worms in the dorsal horns and the central canal of both calves. Extensive traumatic lesions including malacia with microcavitation, were found in all regions of the cord, especially in dorsal horns. The ependyma was frequently destroyed. Neuron loss and degeneration were common findings. Heavy infiltrations of lymphocytes and plasma cells into all regions of the spinal parenchyma were observed. Leptomeningitis was found in practically every section of the cord studied with heavy infiltrations extending into the dorsal sulcus, the ventral fissure, and the dorsal nerve roots. There were foreign body reactions with giant cells around dead worms or their products with numerous areas of gliosis. Ballooning and disappearance of axis cylinders as well as single fibre myelin degeneration were noted commonly in dorsal and lateral funiculi.

Thus, although development of *P. tenuis* in moose was similar to that in deer in the sense that worms, developing mainly in dorsal horns, were at the same level of development as they would have been in deer at comparable times, the amount of traumatic damage done to the parenchyma was much greater. Several factors contributed to bring this about. Firstly, worms invaded and damaged the central canal. Secondly, worms coiled upon themselves in the dorsal horns and inflicted considerable traumatic damage to surrounding tissues; indeed in some places dorsal horns were largely replaced by worms. Thirdly, worms stayed an abnormally long time in the cord and, as growth continued normally, their size alone became a factor in the amount of damage done. Fourthly, the calves seemed to lack resistance to the infection as indicated by the fact that we were able to account for 41 of the 200 worms used for infecting one of the calves; this is a recovery far in excess of that which we have come to expect in deer given even double the number of infective larvae.

Several reports hitherto considered of little importance, take on significance in the light of the hypothesis that *P. tenuis* is the aetiological agent of moose neurologic disease. Fenstermacher found an unidentified nematode in the "brain stem" of a sick moose from Minnesota. Dikmans and Wehr reported unidentified nematodes from the eye of one of the sick moose studied by Fenstermacher. Benson found an unidentified nematode in the "brain" of a sick moose from Nova Scotia. King's and Benson's histopathologic findings in the brains of sick moose from Minnesota and Nova Scotia are consistent with the cerebrospinal nematodiasis we have described in fawns and moose calves. We reported that development of *P. tenuis* in moose was similar to that in deer and that first-stage larvae like those of *P. tenuis* were found in the faeces of a moose from Algonquin Park. Most recently Smith *et al.* recovered *P. tenuis* from the cranium of sick moose from Nova Scotia and New Brunswick. Within the past two months eggs and larvae were found in the eyes and adults, larvae, and eggs in the brain parenchyma and cranial subdural spaces of two moose calves exhibiting neurologic signs from the Kenora district of Ontario. Additional support comes from the fact that the known distribution of the disease indicates its occurrence only in regions where white-tailed deer and moose overlap in abundance. We are thus able to explain its absence in such places as Newfoundland and Isle Royale where there are no deer. Although none of the above facts taken individually presents a convincing case for believing that *P. tenuis* is the aetiological agent, taken together with our experimental findings, they strongly suggest that this hypothesis is correct.

We have already noted that *P. tenuis* of *O. virginianus* and *P. odocolei* of *O. hemionus* are not members of the genus *Elaphostrongylus* although they have unmistakable affinities to the metastrongyles of Eurasian cervids some of which have also been implicated in neurologic disease. In addition, we have noted the relatively minor pathogenicity of *P. tenuis* and its remarkable ubiquity in white-tailed deer. These latter points are indicative perhaps of a long and well-established host-parasite relationship. Many specialists believe that *Odocoileus* has had an ancient North American history since the genus is unique to this continent. It is tempting to speculate that the ancestors of *Odocoileus* brought with them from Eurasia a metastrongyle which, along with the deer, evolved into an unique genus represented by two species, one on the west coast in *O. hemionus,* the other is *O. virginianus* of the eastern part of the continent.

Moose are considered by many specialists as more recent arrivals to North America from Eurasia. Possibly there was not originally too much contact between moose and white-tailed deer because one was confined largely to the southern parts of the continent and the other to the northern parts. There seems to be considerable evidence that the white-tailed deer has recently extended its range northward and increased markedly in areas where moose were once predominant. Thus, moose may first have been exposed on a large scale to *P. tenuis,* a parasite to which they are apparently highly susceptible and poorly adapted (cf. the pathogenicity in deer and moose), within recent times. This would help to explain the lack of well-authenticated records of this rather spectacular disease prior to about 1912 and why it seems to occur precisely in those areas on the southern limits of moose distribution where moose and deer come into contact in greatest numbers. If this were true we might expect moose neurologic disease to become an increasingly important problem if deer continue to extend their range northwards in abundance and especially if *P. tenuis* proves capable of becoming established in moose herds. Studies of the distribution of *P tenuis* and of the past and present relationship between the two cervids may help to clarify this problem. It would be prudent, however, to use caution in identifying worms found in the central nervous system of moose. No protostrongylid metastrongyle specific to *Alces* has yet been reported but this is not proof that such a species may not exist and become a complicating factor in studies of cerebrospinal nematodiasis.

P. TENUIS AND NEUROLOGIC DISEASE OF SHEEP

P. tenuis (under the names of *Neurofilaria cornellensis* and *Elaphostrongylus tenuis*) has been reported in the spinal cord of sheep with neurologic signs in New York and Pennsylvania. These diagnoses were based, however, on small fragments of worms dissected from the cord and found in histological sections. The caudal extremity of the male worm, essential to identifying protostrongylines to species, was not mentioned by the above authors and was presumably not found.

Since the spring of 1963 we have, in co-operation with the Ontario Veterinary College, given infective larvae of *P. tenuis* to four lambs. Control and experimental lambs were kept together. One lamb given 50 and another 100 larvae apparently did not show neurologic signs although they were not kept under close observation by professional staff. Study of the central nervous system of both animals three months after infection revealed a few dead worms and unmistakable evidence that worms had been active in the cord. A third lamb given 170 larvae became ataxic 27 days after infection but recovered quickly and failed to show additional signs until the 61st day when it had difficulty rising. The left hind limb became paralyzed and the lamb died on the 63rd day. Most of the cord was pressed between glass plates in an unsuccessful attempt to find worms but a sizable infiltrated lesion containing a dead worm was found in sections of the medulla oblongata. A fourth lamb given 1000 larvae could barely rise 10 days after infection. The most obvious sign was a profound weakness although the left hind leg was slightly ataxic. The animal held its head low and the ears dropped. Irregular spasms shook the body. By the 15th day the lamb could not stand unassisted and it was autopsied. Eighteen worms, found in the parenchyma of all regions of the cord, were associated with considerable tissue destruction. These preliminary results show that *P. tenuis* can be pathogenic to sheep. The disease might easily go unrecognized or be incorrectly diagnosed. Careful studies of flocks in areas where there are white-tailed deer might be illuminating.

SUMMARY

A review is given of knowledge concerning the distribution, development, transmission, and pathogenesis of *Pneumostrongylus tenuis* of white-tailed deer. The evidence in favour of the hypothesis that *P. tenuis* is the aetiological agent of neurologic disease in moose is presented. It is suggested that *P. tenuis* and the related species *Parelaphostrongylus odocoilei* in deer of the west coast, are unique to *Odocoileus* and have had a long association with these deer. Furthermore, the moose may be a relatively new and poorly adapted host for *P. tenuis*. Moose may have come in contact with *P. tenuis* recently as a result of the northward extension of the range of white-tailed deer. The relationship of *P. tenuis* to neurologic disease in sheep is discussed briefly.

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DISCUSSION

DISCUSSION LEADER HERMAN: Of course we must all understand that this isn't something that Dr. Anderson worked up overnight. He has been working on it many years and many of his colleagues and parasitologists consider it one of the most outstanding pieces of research in recent years. His paper is now open for discussion.

DR. E. BOSSENMAIER, Manitoba: I would like first of all to congratulate the doctor for this very excellent paper because it does mean a lot to us in Manitoba where we have this so-called mysterious moose disease. But I would like to ask one question and that is, have there been any records in the literature or in any of your own work where there have been moose autopsies where this particular parasite has not been found, but where the symptoms beforehand indicated this disease?

DR. ANDERSON: A good many moose have been examined that were exhibiting neurologic signs, with nothing helminthic being found. But then nothing else was found for that matter. To look for helminths in the nervous system requires a great deal of effort. We probably cut up to 60 to 70 blocks of tissue from each moose to find these worms and I think this is perhaps the explanation for it. I think when we look for it we will find it. As a matter of fact, we have demonstrated this very recently in Ontario.

DR. ROBERT WEEDON, Alaska Department of Fish and Game: Have you isolated the larvae from the mollusk that is the secondary host?

DR. ANDERSON: I don't quite know what you mean by isolated.

DR. WEEDON: Have you discovered it in a specific kind of mollusk?

DR. ANDERSON: We don't know which species are involved in the field. We have exposed and successfully infected seven or eight species that are common in the area where there are the white-tailed deer. We don't know which are more important.

DR. WEEDON: I wondered, as a final question, whether the distribution of the mollusks would also have some bearing on that?

DR. ANDERSON: Yes, I should expect it would have. We don't know a great deal about it yet.

DISCUSSION LEADER HERMAN: Roy, have you found any naturally infected mollusks at any time or looked for them?

DR. ANDERSON: Yes, last year I found two terrestrial mollusks that were naturally infected. One was a *Succinia* and the other was a *Discus*.

KOREAN HEMORRHAGIC FEVER

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INTRODUCTION

It now has been over ten years since the United States Army first encountered hemorrhagic fever during military operations in Korea. In many ways the disease remains an enigma, despite several years of the most intense medical research by workers of almost every conceivable scientific discipline related to medicine. The purpose of the present report is to provide a short historical summary of the experience of the United States military forces with the disease, the epidemiological observations which were made, and the more recent developments in the study of the disease.

It is somewhat unfortunate that the clinically descriptive term "hemorrhagic fever" has been applied to such a large number of different diseases in several parts of the world. In addition to the disease under discussion here, and the related or identical clinical entities in Europe, there are quite different human diseases transmitted by ticks on the Eurasian land mass, not to mention recently detected diseases in the Neotropical region, and mosquito-borne viral diseases in Southeast Asia, all bearing the name hemorrhagic fever. A number of Russian workers have proposed the term "hemorrhagic fever with renal syndrome" for the specific disease under discussion here, and this may be a more restrictive and proper name than others which have been applied. Some of the bewildering names which have been used for the Korean form of the disease will be mentioned below in the historical review of American, Russian and Japanese experience with the disease.

United States military forces first experienced cases of a febrile disease with renal involvement in Korea in May 1951. At that time, U. S. military forces had been operating at various points in Korea for about a year, but as the pattern of geographical and seasonal distribution of the disease unfolded it became apparent that the troops generally had not been exposed to the disease the previous year, when operations were largely limited to areas far to the south of the 1951 battlefield. In general, the disease in Korea was confined to the area north of Seoul, in the general vicinity of the 38th parallel. The disease was characterized by fever, petechial rash and evidence of damage to the kidneys in the more severe cases. Fatality rates varied from five to seven percent. At first, leptospirosis, in one of its more virulent forms was suspected as the causative agent, but all efforts to demonstrate the presence of these organisms by isolation or serology failed. An examination of the Russian and Japanese literature revealed that similar disease episodes had been seen by them in Northeast Asia some years earlier.

RUSSIAN AND JAPANESE EXPERIENCE

Much of the early experience of the Russians and Japanese with hemorrhagic fever in the Far East was summarized by Meyer (1952) and Gajdusek (1953). The Russians first encountered the disease in 1934 in the Amur river basin and other areas of the Soviet Far East. The local forms were described under a bewildering variety of patronymic or geographical terms, many of which have been listed by Povalishina and Yankovskii (1933). The early epidemiological and clinical investigations were summarized by Smoradinttsev, Chudakov and Churilov (1959). The disease appeared to be associated with valleys and lake-side meadows, occurring chiefly in the months of May to September. It also appeared to be correlated with the appearance of large populations of small murine rodents in sparsely inhabited areas. The Russian workers found no evidence of man-to-man transmission, nor of transmission through food or water. The appearance of cases in the colder months also ruled out a winged arthropod vector. The agent was found to pass bacteria-tight filters, and to be transmissible to human volunteers by inoculation. It could not be transmitted to any known laboratory animal with predictable success.

The Japanese first encountered hemorrhagic fever in Manchuria around 1939. They too applied a number of names (Songo fever, Kokka disease, Korin fever, etc.) to the disease, before general agreement was obtained on the term "epidemic hemorrhagic fever." The Japanese soon suspected that they were dealing with the same disease entity as that described by Soviet workers. They too postulated a murine rodent reservoir for the disease; and they too were able to pass the virus to man by inoculation, but not to any laboratory animal. The Japanese implicated a gamasid mite, *Laelaps jettmari* Vitzthum, as a possible vector of the virus. The Russians had also indicated that gamasid mites might play a role in the transmission of the disease.

EPIDEMIOLOGY IN KOREA

The epidemiological observations by American workers in Korea have been summarized by Gauld and Craig (1953), Marshall (1954) and Smadel (1959). Approximately 2,000 cases of epidemic hemorrhagic fever were seen in United States and United Nations troops from 1951 onward. These generally occurred as single cases, or as small clusters of cases. Where clustering of cases occurred, the outbreaks were generally limited in time of onset to the presumed incubation period of the disease (9 to 45 days), and there was no evidence of secondary infection from man to man. As a rule, the time of onset of the cases in a single small unit were very close, leading to the conclusion that they had been contracted simultaneously. In some respects this situation strongly resembled the military experience with scrub typhus elsewhere in Asia (Traub *et al.*, 1954). Because of the frequent movement of troops it was difficult to determine the exact point at which infection took place, but all foci appeared to be limited to the region north of approximately 37° 27′ North Latitude, and to very restricted portions of the region. From 1951 to 1953, the years in which cases were abundant, there were two distinct seasonal peaks of hemorrhagic fever cases—a lower peak in June, and a higher one in October to November. A very large scale study of the rodents and ectoparasites in Korea led several workers (Traub *et al.*, 1954 and Marshall, 1954) to conclude that the disease might be correlated with increases in the rodent population incident to the abandonment and subsequent reoccupation of agricultural land. Fleas, ticks, gamasid mites, chiggers and other ectoparasites were collected from the mammals and tabulated by time and place of collection and host. Fleas and ticks were generally scarce, and gamasid mites had a seasonal pattern unrelated to the hemorrhagic fever epidemics. Only chiggers, the larval stage of mites of the family Trombiculidae, showed a seasonal periodicity which approached that of the hemorrhagic fever outbreaks (Traub *et al.,* 1954). These arthropods appeared to meet the criteria listed by Gauld and Craig (1953) for a vector of hemorrhagic fever, namely: limited movement, wide distribution in the epidemic zone, seasonal prevalence and having a bite not irritating to man. On the basis of these findings a program of treatment of clothing with miticidal materials (Dews and Marshall, 1954), combined with rodent control, was instituted. It is probable that these empirical measures contributed to the declining incidence of the disease from 1953 onward, but it is difficult to assess their importance for a number of reasons. Perhaps the most important of these is the fact that a truce was concluded in 1953, resulting in a realignment of U. S. forces, generally away from what were presumed to be the most dangerous areas.

The greatest difficulty encountered in the study of the disease in Korea, and a factor which contributes greatly to the difficulty in assessing the meaning of the epidemiological observations, was the failure to isolate the causative agent in any known laboratory animal. This occurred, despite the most intensive efforts utilizing rodents, primates, tissue culture systems, arthropods, and every conceivable alternative. Lack of isolation of the organism responsible for hemorrhagic fever prevented etiological diagnosis, or the development of a serological test which might throw some light on the epidemiology of the disease. Thus, neither the Americans, nor the Russians, nor the Japanese succeeded in definitely isolating the presumed viral agent for continued detailed study.

In recent years, approximately ten to fifteen cases of hemorrhagic fever have appeared each year in the U.S. military forces remaining in Korea (Metzger, 1964). Mite control and rodent control measures have continued but laboratory investigations by American investigators have been largely concluded.

RECENT INVESTIGATIONS

Russion workers (Anon., 1962; Povalishina and Yankovskii, 1963; and Zdanov, 1964) reviewed the most recent studies on the disease in the U.S.S.R. and elsewhere in Europe. Hemorrhagic fever with renal syndrome (as some Russian workers now refer to the disease) is now known to occur in various parts of the U.S.S.R. including the Moscow, Minsk, and Murmansk regions, and areas in the Urals, Ukraine and Moldavia. In addition, what are believed to be identical diseases have been reported from Finland, Sweden, Bulgaria, Yugoslavia, Czechoslvakia, and other areas in Europe. Precise diagnosis still remains problematical, for all attempts to isolate the virus regularly in laboratory animals have failed. The Russian workers (Zdanov, 1964) still feel that the presence of large numbers of rodents is a requisite for the appearance of the disease in an area. The mode of transmission from the rodents to man has not been determined. Most Soviet workers feel that gamasid mites serve as vectors, especially when the mites occur in human dwellings during the fall of the year. However, human contact with rodent excreta cannot be excluded as a source of infection (Smadel, 1959). Some Russian workers have discounted the role of chigger vectors, at least in those parts of the range of the disease where cases occur while it is too cold for chigger movement (Anon., 1962).

With the detection of epidemic hemorrhagic fever in European countries other than Russia, it may be well to consider the possible extension of the disease to the Nearctic area. No evidence has been found thus far to indicate such an extension, but it is a possibility which should be borne in mind, particularly where large population fluctuations occur in wild rodent communities. The Russians have emphasized the probable role of *Microtus* in the epidemics, and closely related voles are found in the Nearctic Region. The Japanese felt that *Apodemus* species were involved in Manchuria. Members of this genus do not occur in North America.

Recently, epidemihemorrhagic fever investigations have been reopened at the 406th Medical Laboratory, United States Medical Command, Japan (Metzger, 1964). This study includes attempts to isolate the causative organism from rodent blood, urine and feces collected in the endemic area; and from human blood, urine and feces collected from cases in the first three days of illness. Tissue culture techniques have advanced rapidly since the earlier investigations in Korea, and the newer methods will be used in a further attempt to provide the missing element which may finally permit the complete understanding of this disease—the isolation of the virus.

As has been the case since 1952, the protection of U.S. military forces in Korea still depends on the treatment of clothing with miticides, the use of repellents and attempts to keep the rodent populations at as low a level as possible.

SUMMARY

The United States Army first encountered hemorrhagic fever during military operations in Korea in 1951. Japanese and Russian workers had investigated the disease some years earlier in maritime

portions of Asia, and had implicated rodents and gamasid mites in the natural disease cycle. The American investigations in Korea pointed to the involvement of wild rodents and chigger mites. However, none of the investigators who have dealt with the disease has been able to isolate the causative organism in experimental animals, which greatly hampers diagnosis and epidemiological investigations. The Japanese and Russian investigators showed that the disease could be transmitted to human volunteers by inoculation, and demonstrated that the agent, persumably viral, could pass bacteria-tight filters.

More recently, new foci of hemorrhagic fever with renal involvement have appeared in the Moscow region, and further to the west in several European countries. The best evidence available presently is that outbreaks involve large populations of wild rodents, and that transmission to man may be by arthropod bite, or through direct contact with rodent excreta. Protection of United States military forces in Korea still depends on the use of miticidal repellents on clothing and skin, and on rodent control. The number of cases annually in Korea has been small since the armistice was signed in 1953.

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DISCUSSION

DISCUSSION LEADER HERMAN: Thank you very much. If I may, I can point out that during World War II, most of the effort of Army medical personnel aimed at specific diseases was devoted to malaria, with some being devoted to things like dengue fever and schistosomiasis. With this disease along with other events that occurred at the time and subsequently, the Army has taken a tremendous interest in diseases in wildlife, recognizing that many of the diseases of importance in Army theatres of operation are also diseases of wildlife. It has made a great contribution to our knowledge of wildlife disease.

I might point out that in our program we will have another paper on a related disease that occurs in wildlife, deer hemorrhagic fever which may or may not be related to the group that includes the Korean virus.

MR. W. T. HUBBART (San Francisco, Calif.): Of these other agents, I believe the Bolivian hemorrhagic fever, at least, has been isolated. Have any of the cases of the Korean virus shown any cross-breeding reactions?

MAJOR SCANLON: I believe that this has not been investigated. I am sure it hasn't We have few people presently active in this field. Dr. Yuill is here from the virus department. He might have some idea whether they are working with that presently, or are they? I am almost certain that they are not.

DR. YUILL: To my knowledge, all they have done with hemorrhagic fever in South America is to show the relationships of the three distinct viruses that have been isolated, one from Trinidad, one from Bolivia and the other from Argentina, and to my knowledge there has been no relationship established with hemorrhagic fever at all.

MAJOR SCANLON: And I strongly suspect that nothing much will be done with it by anyone unless an agent is finally isolated from the Korean form. But this certainly deserves some attention if someone could find the time.

DR. LARS KARSTAD (Ontario Veterinary College, Guelph, Ontario): Do you feel that it is definitely proven that rodents are involved, or is this pretty much circumstantial evidence?

MAJOR SCANLON: Specifically on the Korean form? No, I don't think it has been definitely proven because there is a relationship in time and space and there is evidence for believing it. The Russians have succeeded in transmitting from animals to man and succeeded in producing a disease which is exactly like the disease seen in Asia. And they have succeeded in transmitting from man to *Microtus* mice for one passage and then were not able to transmit again from that passage of *Microtus* to the next. They produced death in *Microtus* by innoculation of material. But I think it is still an open question.

DR. KARSTAD: This was my impression from what I heard and read. It seems strange to me if it is really an infection of wild rodents it has not been possible to propagate it in laboratory rodents or perhaps even in wild rodents in the laboratory.

MAJOR SCANLON: There are still other postulates open to account for the disease, but people are not currently working on them although they are thinking about them.

DR. WILLIAM H. LAWRENCE: (Centralia, Washington): John, what is the incidence of this disease among the Korean natives?

MAJOR SCANLON: There is no very accurate information on what occurred in Korea before we first saw an outbreak. Most of our people became infected in areas from which most of the native population had been removed. You participated in this to an extent, too, I believe.

I don't know what the situation is currently. Lt. Knight tells me there is information available from the Korean public health people. I have not seen it and I have no idea. He might like to comment on that.

LT. KNIGHT: The R.O.K. medical people are doing work on this as far as they can, which is very crude in reflecting ectoparasites. It is still a big problem with 300 to 400 cases a year and a 10 percent mortality rate.

In the native population they have so many diseases I don't think you can pin the cause down to one thing. If somebody dies, they don't worry about it too much.

SARCOSPORIDIOSIS IN DUCKS IN LOUISIANA

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Sarcocystis rileyi has been evident in wild ducks for many years and the literature cities incidences from practically all portions of the United States. However, numerous inquires from hunters in recent years suggested that the parasite may be epizootic in Louisiana and prompted this study.

The study was begun in 1960 and aimed primarily at determining the species affected and the levels of infestation. The study was then expanded to compare infestation between age and sex groups and different areas in the state.

Louisiana usually winters from 5 to 6 million ducks with Mallard (*Anas platyrhynchos*), Pintail (*Anas acuta*), Green-winged Teal (*Anas carolinensis*), Gadwall (*Anas strepera*) and Lesser Scaup (*Aythya affinis*) the major species. However, Baldpate (*Mareca americana*), Blue-winged Teal (*Anas discors*) and Shoveler (*Spatula clypeata*) combined number well over one million birds. Also, the Mottled Duck (*Anas fulvigula*), though not present in such great numbers, is native to Louisiana and very important to hunters in Southern Louisiana.

STUDY METHODS

From 1960 to 1964 while collecting duck gullets at a hunting club in Creole, Louisiana and at the Pass-a-loutre Waterfowl Management Area, I had an opportunity to examine a number of ducks for Sarcosporidia infestation. The ducks had been picked and the wings cut off near the body. By raising the skin at the wing it was possible to examine the breast and wing muscles without disfiguring the bird. The lower portion of the breast and the legs were examined by looking through the skin. Consequently, the figures presented represent only a minimum, since infestation in a few ducks may have been overlooked.

The ducks examined were tabulated by species, sex and age and the parasite listed as present or absent in each bird. For infested birds the degree of infestation was estimated and classified as light, intermediate and heavy. Light infestation included those cases where the parasites were very sparse, with less than one cyst per square inch of body surface. Intermediate included those with between 1 and 5 cysts per square inch, and heavy those with dense concentrations of the cysts and exceeding 5 per square inch of body surface. Several ducks were examined which had in excess of 25 cysts per square inch of body surface.

RESULTS

Variation Among Age Groups. The data from earlier studies on *Sarcocystis* by the writer (Chabreck, 1961) were not broken down into age groups. However, it was obvious that if the data were to be compared from year to year age grouping was necessary, because of the variation in age ratios from year to year. Ages were determined by cloacal examination and the birds simply classified as adult or immature.

Shillinger and Wetmore (1938) stated that very young animals are seldom affected. They believed this was due to the time it takes the parasite to become established in the muscle after the introduction of infective spores.

The same condition was found during this study (Table 1) and of 552 immature ducks examined only 0.4 per cent were infested (one Shoveler and one Pintail). Of 961 adults checked at the same time 35.7 per cent contained sarcocystis.

TABLE 1. AGE[1] IN RELATION TO SARCOSPORIDIOSIS INFESTATION IN DUCKS IN LOUISIANA, 1961-1964

Species	ADULT		IMMATURE	
	No. Examined	Percentage Infested	No. Examined	Percentage Infested
Mallard	250	27.2	154	0
Pintail	365	44.4	143	0.7
Blue-winged Teal	79	48.1	63	0
Green-winged Teal	19	47.4	6	0
Baldpate	61	23.0	34	0
Gadwall	55	9.1	72	0
Mottled Duck	63	11.1	19	0
Shoveler	46	78.3	34	2.9
Lesser Scaup	23	17.4	27	0
All Ducks	961	35.7	552	0.4

[1] The difference between adult and immature ducks was significant to the 99 percent binomial level for all species. (Mainland, Herrera and Sutcliffe, 1956).

A comparison of Sarcosporidiosis in adult versus immature ducks was significantly different at the 99 per cent binomial level for all species checked.

Examinations during the spring failed to show any change in infestation. No immature Shovelers checked as late as March were parasitised, but adults examined at the same time displayed the same high rate.

Differences Among Sexes. Only adult ducks were used for making this comparison because of the very low incidence among immatures and the variability of age ratios from year to year. The sarcocystis infestation of both sexes of adult ducks was very similar (Table 2).

TABLE 2. SEX[1] IN RELATION TO SARCOSPORIDIOSIS INFESTATION IN ADULT DUCKS IN LOUISIANA, 1961-1964

Species	ADULT MALE		ADULT FEMALE	
	No. Examined	Percentage Infested	No. Examined	Percentage Infested
Mallard	169	29.6	81	22.2
Pintail	288	45.5	77	40.3
Blue-winged Teal	53	49.1	26	46.2
Green-winged Teal	14	50.0	5	40.0
Baldpate	44	22.7	17	23.5
Gadwall	33	9.1	22	9.1
Mottled Duck	50	6.0	13	30.8
Shoveler	33	72.7	13	92.3
Lesser Scaup	14	7.1	9	33.3
All Ducks	698	36.5	263	33.5

[1] The difference between males and females was non-significant on all species except Mottled Ducks which was significant at the 99 percent binomial level.

A comparison by species showed no significant difference on all species except the Mottled Duck. Adult males displayed a much lower rate on this species, but I suspect that the difference reflects an error in the aging technique. The Mottled Duck is a very early nester and many immature males develop adult characteristics by winter, consequently many immatures not parasitised were classified as adults.

The totals for all species examined showed 36.5 per cent of the adult males and 33.5 per cent of the adult females with sarcosporidia.

Variation Among Species. The literature reports numerous incidences of Sarcosporidiosis in various species of mammals, reptiles and birds. All species in these classes are probably susceptible to the parasite, but certain species seem to pick it up more readily than others.

This is quite evident in ducks and Erickson (1940) reported that of 279 ducks of 18 species in Minnesota only 6 Mallards and 2 Shovelers were parasitised. Also, he reported that of 43 ducks of 8 species only Mallards were parasitised.

From studies in Utah, McDonald (1961) reported a very high incidence in the Shoveler, but of 113 other dabbling ducks only one Green-winged Teal was infested. Of 35 Mallards in this sample none were parasitised. Also, in quoting from the work of Quortrup and Shillinger at the Bear River Rsearch Laboratory, Utah, McDonald stated that of 1,397 ducks the researchers found the Shoveler with greatest infestation, followed by Green-winged Teal, Gadwall and Pintail.

The data from Louisiana (Table 3) were similar to that from Utah in regard to the species rating. However, of the 1,513 ducks examined in Louisiana all species of the 9 checked were infected. Shovelers were by far the most heavily parasitised with Blue-winged Teal, Green-winged Teal, and Pintail following respectively in a close group. It is interesting to note that these species are all early migrants, arriving in Louisiana approximately one month earlier than the other species.

The parasite has not been found in Blue Geese (*Chen caerulescens*), Lesser Snow Geese (*Chen hyperborea*) *or Coots* (*Fulica americana*) in Louisiana; although hundreds of these have been examined.

Degree of Infestation. In ducks with *Sarcocystis* there was practically no difference in the degrees of infestation for most species (Table 3). All levels of infestation from light to heavy occurred at relatively equal rates on individual species. Only in the Green-winged Teal and the Shoveler were the differences in the degrees of infestation significant. A significantly greater percentage of the parasitised Green-winged Teal had light infestation, while the Shoveler had a heavier infestation.

Variation Between Years. Sarcosporidiosis in ducks varied at only a small rate from year to year (Table 4). Only in the Mallard and Blue-winged Teal was a significant difference (95 per cent binomial level) found in infestation between years. Also, for these species the difference was only between the Winter 1961-62 and Winter 1962-63. "Chi square" tests between annual variations in the average for all ducks showed significance only between 1961-62 and 1962-63 (95 per cent confidence level).

Variation Among Areas. In regard to the distribution of *Sarcocystis* Beaudette (1941) stated that the parasite in birds was probably widespread but escapes notice because infected birds may appear normal and because infection is not discovered unless the muscles are exposed. Also, Gower (1938) stated that since ducks are highly migratory, the location of parasitised birds means nothing.

Of the many accounts of Sarcosporidiosis in the literature many writers describe the condition in ducks brought in for examination. However, Erickson (1940) and McDonald (1961) examined ducks for

TABLE 3. SARCOSPORIDIOSIS INFESTATION IN ADULT DUCKS IN LOUISIANA, 1961–1964

Species	No. Ducks Examined	Percentage Infested	Binomial Level[1]		Degree of Infestation (%)			Chi sq.[2] (df = 3)	
			95%	99%	Light	Intermediate	Heavy	95%	99%
Mallard	250	27.2	S.	S.	8.0	9.6	9.6	N.S.	N.S.
Pintail	365	44.4	S.	S.	16.7	15.9	11.8	N.S.	N.S.
Blue-winged Teal	79	48.1	S.	N.S.	19.0	18.0	11.4	N.S.	N.S.
Green-winged Teal	19	47.4	N.S.	N.S.	36.8	5.3	5.3	S.	N.S.
Baldpate	61	23.0	S.	N.S.	13.1	8.2	1.6	N.S.	N.S.
Gadwall	55	9.1	S.	S.	3.8	5.5	0	N.S.	N.S.
Mottled Duck	63	11.1	S.	S.	3.2	6.4	1.6	N.S.	N.S.
Shoveler	46	78.3	S.	S.	8.7	21.7	47.8	S.	N.S.
Lesser Scaup	23	17.4	N.S.	N.S.	0	4.4	13.0	N.S.	N.S.
Total	961	35.7			12.4	12.5	10.8		

[1] Binomial level used to test the variation among species when compared with the mean infestation for all species.
[2] "Chi square" test were made between three degrees of infestation and expected values were based on average infestation levels for all species.

TABLE 4. ANNUAL VARIATION[1] IN SARCOSPORIDIOSIS INFESTATION OF ADULT DUCKS IN LOUISIANA

Species	Winter 1961–62		Winter 1962–63		Winter 1963–64	
	No. Examined	Percentage Infested	No. Examined	Percentage Infested	No. Examined	Percentage Infested
Mallard	81	35.8	61	19.7	104	24.0
Pintail	88	37.5	100	45.0	145	48.3
Blue-winged Teal	18	72.2	18	44.4	35	40.0
Green-winged Teal	6	66.7	2	0	10	50.0
Baldpate	8	50.0	4	25.0	26	19.2
Gadwall	8	12.5	4	25.0	14	21.4
Mottled Duck	11	18.2	28	14.3	19	5.3
Shoveler	29	72.4	3	66.7	10	100.0
All Ducks	249	43.0	220	33.2	363	36.6

[1] Tests of binomial confidents levels showed no significant difference between years for various species except Mallard and Blue-winged Teal and then only between 1961–62 and 1962–63 at 95% level for these. "Chi square" tests between annual variations in average for all ducks showed significance only between 1961–62 and 1962–63 (95% level).

infestation from a random sample. In Minnesota Erickson found that 2.86 per cent of 279 ducks were parasitised, while McDonald found that 5.11 per cent of 137 ducks in Utah were infected.

Although these figures show that *Sarcocystis* is widespread, a comparison of the infestation rates between regions does not show a true picture, because the data include both adult and immature ducks. Immature ducks are rarely parasitised and age ratios vary from year to year and area to area.

The data from Louisiana (Table 5) show considerable variation among 9 species of adult ducks checked from Southwestern Louisiana and Southeastern Louisiana. The differences between areas for 6 species in this sample was non-significant. However, the difference for 3 species, Gadwall, Mottled Duck and Lesser Scaup, was significant at the 99 per cent binomial confidence level. Also, the

TABLE 5. SARCOSPORIDIOSIS INFESTATION OF ADULT DUCKS FROM TWO SEPARATE AREAS IN LOUISIANA, WINTER 1963–64

Species	Southwestern La. Cameron Parish		Southeastern La. Plaquemines Parish		Binomial Confidence Level	
	No. Examined	Percentage Infested	No. Examined	Percentage Infested	95%	99%
Mallard	104	24.0	4	50.0	N.S.	N.S.
Pintail	145	48.3	32	43.8	N.S.	N.S.
Blue-winged Teal	35	40.0	8	37.5	N.S.	N.S.
Green-winged Teal	10	50.0	1	0	N.S.	N.S.
Baldpate	26	19.2	23	17.4	N.S.	N.S.
Gadwall	14	21.4	29	0	S.	S.
Mottled Duck	19	5.3	5	0	S.	S.
Shoveler	10	100.0	4	75.0	N.S.	N.S.
Lesser Scaup	11	27.3	7	0	S.	S.
All Ducks	374	36.4	113	23.0	S.	S.

differences in the average infestation for all ducks between the two areas were significant at the 99 per cent binomial level.

Source of Infection. The source of infection is not known; however, since parasitised birds are so widespread, the spores which cause infection are probably widespread also. Infective spores can likely be found on both the duck nesting and wintering grounds. The fact that Mottled Ducks, a non-migratory species in Louisiana, were parasitised confirms the idea that this area is a source of infection. The fact that migratory birds from other flyways are parasitised indicates that the northern nesting grounds are probably a source of infection also.

Scott (1930) believed that in certain Sarcosporidia natural infection and transmission may take place at birth. He also believed that infection took place in the spring. Shillinger and Wetmore (1938) thought that the most common source of infection came from ingesting contaminated food or feeding on contaminated ground. They also believed that infestations are likely to occur in the late spring or early summer.

Erickson (1940) found *Sarcocystis* only in puddle ducks and stated that since these birds fed in shallow water or stubble fields, they would be more exposed to contaminated fecal material and have more chance of contacting the parasite. However, the parasite was found in Lesser Scaup during this study. Also, Cornwell (1963) reported *Sarcocystis* in Redheads (*Aythya americana*), Canvasbacks (*A. valisineria*) and Common Goldeneyes (*Bucephala clangula*).

Condition of Infected Ducks. Sarcocystis rileyi apparently has little or no effect on its host. Most ducks examined with the parasite, even in extreme cases, appeared to be in excellent condition. Also, no differences were noted in the behavior of parasitised ducks and all habits, such as flock action, pair formation and feeding, appeared normal.

The weights of parasitised ducks were practically the same as the non-parasitised in the same area at the same time. The differences were not significant. The average weight of 20 adult male Pintails with heavy infestation was 40.1 ounces and the average weight of 29 without the infection was 41.4 ounces. The average for 5 adult male Mallards, heavily infested, was 47.9 ounces and for 19 not infested was 47.1 ounces.

Parasitised Ducks For Food. Sportsmen frequently ask whether or not ducks parasitised with *Sarcocystis rileyi* are harmful if eaten. This species is host specific and will not encyst in humans; also Scott (1930) fund that the toxin from Sarcosporidia (called sarcosporidiotoxin) was harmful only to rabbits (*Leporidae*).

Hall (1925) stated that on esthetic grounds, if for no other reason, the flesh of ducks in question are unfit to eat. Riley (1931) reported that apart from the esthetic grounds and the view that parasitised flesh is unwholesome, the repeated demonstrations with sarcosporidiotoxin indicated that there may be danger in eating excessively infested birds. However, Ranier and Newman (1961) stated that the parsites can be generally considered as harmless to humans and animals and there is no evidence that properly cooked parasitised ducks are harmful.

Most hunters are unaware of the parasites in ducks. However, sportsmen who hunt ducks quite frequently or live in communities with many hunters are generally cognizant of the presence of Sarcosporidia. Only about 20 per cent of the hunters in Louisiana are aware that ducks have Sarcosporidiosis. Of these about 25 per cent examine the birds and discard those heavily parasitised.

SUMMARY

From 1960 to 1964, 1,553 ducks of 9 species were examined for *Sarcocystis rileyi* in Louisiana. For each bird checked records were kept on species, sex, age, location and degree of infestation.

There was a significant difference between age and Sarcosporidiosis. Of 961 adult ducks examined 35.7 per cent were infested, but of 552 immatures only 0.4 per cent were infested.

Sex was not a factor in infestation of adult ducks. Of 961 adults 36.5 per cent of the males and 33.5 per cent of the females were infested. All species checked were parasitised, but the Shoveler was the species having the greatest infestation rate with 78.3 per cent among adults. Blue-winged Teal, Green-winged Teal and Pintail followed respectively.

No great difference was noted in the annual occurrence of Sarcosporidiosis. The winter of 1961-62 was the highest with 43.0 per cent of the adult ducks. In 1962-63, 33.2 per cent were infested and in 1963-64, 36.6 per cent.

Comparing the infestation rates between two areas, Cameron Parish in Southwestern Louisiana had 36.4 per cent, while Plaquemines Parish in Southeastern Louisiana had 23.0 per cent. The fact that only a small sample was available in Plaquemines Parish on most species may have caused this difference. A large sample of Pintail was examined in both areas and Sarcosporidia infestation from both areas was very similar.

ACKNOWLEDGMENTS

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DISCUSSION

DISCUSSION LEADER HERMAN: This organism, sarcosporidiosis, the genus name is *Sarcocystis rileyi*, has been known to parasitologists for several centuries. It is remarkable that it is so widespread and yet we know so little about it. We do not know anything of its life cycle in waterfowl or any of the species that occur in birds. I think it is important to add as much information in this direction as we can obtain from each study of incidence that is undertaken and I have one question, particularly, that I would like to have clarified.

As I analyze your data, there were only two birds that you classified as immature in which you found parasites. I think because of the importance of knowledge in this direction, not knowing how long the infection takes, that we should have further documentation of your source of information in deciding that these were immature birds. I would like to get this into the discussion if you would, so we have this in the record regarding these birds.

MR. CHABRECK: We were really surprised to find these two immature birds parasitized because in all the work we had done previous to this the immature birds were never infected. So we made a careful check to make sure (by internal examination) these were immature birds and to confirm this. Most researchers think that the reason the immature birds are not infected is because possibly of the time that it takes the parasite to go through the cycle where it will show up as a cyst in the muscle tissue.

DISCUSSION LEADER HERMAN: I would like to raise one other point in your presentation. We, all of us, have found in the literature statements of this being harmful or not harmful, and you have taken the tack that it is not harmful because of the evidence that is available. But let us remember that we are only seeing one stage of the parasite. We know nothing of how it gets into the bird's muscles and what it might be doing to the host before it gets there. There may be stages in the early development that are doing tissue damage that pathologist or researchers have not yet found. All we can say is that in the stage we have recognized grossly in the muscles there is no apparent harm being done to the host.

MR. PENTON [Walter Reed Institute of Research]: I would like to inquire if you have reference material from earlier years? You had three years. Do you have information from earlier years on the incidence?

MR. CHABRECK: No. We will have four years. The first year did not include the breakdown into age groups so this was not included in this report although the results were very similar for all ducks.

MR. PENTON: I would just like to add, as an old hunter who hunted in Louisiana in the thirties and who skinned his ducks, in those days the shoveler was the only species in which this was common. It was quite uncommon in the other species. So I think historically over a period of years there may have been a change. That is why I mentioned this point.

MR. CHABRECK: Yes, I think there are a lot of other hunters I have talked to who have hunted in earlier years there and they say it was present, but very uncommon.

DR. MARCHETTE [San Francisco]: Have you looked for this parasite any place else in the bird? Presumably, it has to travel through the bird some way to get into the muscles. Have you looked for it in other places in different stages?

MR. CHABRECK: No, in the study we were just mainly interested in the distribution of the parasite in the species and in the areas of the state.

DR. A. B. COWAN [Michigan]: I would like to ask the source of your specimens? I would rather rate them by the sex and age ratio, where you show this, where we have about a two-to-one preponderance of adults, and if we compared the females to the juveniles, we had two juveniles for each female. We compared the sexes of the adults and we had about two males for each female in this case.

I am wondering about the source of your birds and the manner in which they were collected.

MR. CHABRECK: The birds were killed by hunters at local hunting clubs in the southwestern Louisiana area. The birds had been processed, picked with the wings cut off near the body and it was possible to view the breast and the wing muscles of these birds by raising the skin. They were supposedly just taken at random by the hunters.

MR. JOHN SPAULDING [Alabama]: I am strictly a layman with the Wildlife Federation, and I am a duck hunter. The feeding habits of your shoveler are considerably different from the feeding habits of the other ducks you mentioned. Am I correct in that?

MR. CHABRECK: The shovelers will eat a lot of animal material, but there are other ducks that do this, so I wouldn't think it would be so much different from all the other ducks. Surely it is different from some like the mallard or the blue winged teal, but there are other birds which have similar feeding habits.

MR. SPAULDING: But it is primarily a bottom feeder?

MR. CHABRECK: It will feed on the bottom vegetation and on animal material, including small fishes that it catches in the water.

DR. GEORGE CORNWELL [V.P.I.]: About five years ago I was in Canada collecting ducks in northern Manitoba and I had an Indian guide by the name of Duncan. We were out shooting shovelers and he couldn't understand why we collected shovelers because they were worthless to the Indians because they had worms in the breast meat and it was the only species the Manitoba Indians rejected because of the high incidence of sarcosporidiosis.

CHAIRMAN FALLIS: I would like to ask one rather embarrassing question although I don't mean it that way. If you don't know how it is transmitted, how do you know it is not transmitted to man?

The other question, does it show predilection for the outer layer of muscle or if you cut sections might you not find some of your so-called negative ducks are positive?

MR. CHABRECK: That is a possibility. In our examination we could have overlooked some of the ducks and I will emphasize that this data represents only a minimum. It possibly could have had a higher infestation rate than what is listed here. The parasite does occur at depth within the muscle tissue and this may also have caused us to overlook the parasitation of a few of the birds.

MR. JAMES HOLSBURY [Ohio]: In your paper, did you state that you believed this parasite was found both in the nesting and in the wintering birds? I was wondering if the literature showed any studies that had been done on ducks of similar species to the ones you did, in areas where they wintered over north of Louisiana, in Kentucky, Ohio, Illinois?

DISCUSSION LEADER HERMAN: I am going to take the prerogative of answering this question. I think the data that we have doesn't show any particular area, because we have too little information on young infections. Perhaps this is the only one that has been documented where we definitely know we have only two immature birds. So in having the infection in birds over a year old, it would be difficult to answer this question. More data along this line are certainly needed.

HOST-PARASITE INTERRELATIONSHIPS IN RODENT BOT FLY INFECTIONS[1, 2]

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In North America, cuterebrid bot flies characteristically produce myiasis of rodent and lagomorph hosts. In addition these insects parasitize a wide range of non-rodent hosts including deer, cattle, cats, dogs, hogs, mules, and man (Green, 1956; Knipling and Bruce, 1937; Longhurst and Douglas, 1953). The large maturing bot fly larvae are conspicuous within swollen skin cyst, or warbles. There is little detailed information on this host-parasite association and many reports consist of happenstance observations of "warble" occurrence. Most studies of these parasites have dealt with late larval and pupal stages and with the longevity of a small number of adult flies. Such investigations have been based on trapping of naturally infected rodents or on following the infection in a limited number of individual hosts (Bennett, 1955; Haas and Dicke, 1958; Penner and Pocius, 1956; Radovsky and Catts, 1960; Wecker, 1962).

Development of a procedure for laboratory colonization of cuterebrid bot flies (Catts, 1964) permitted investigation of many formerly unexplored aspects of host-bot fly interrelationships. This paper is a report on laboratory studies of host-parasite interrelationships in myiasis infections caused by two colonized Californian species of *Cuterebra*: *C. approximata* Walker and *C. latifrons* Coquillett. The former was colonized as a parasite of the deer mouse, *Peromyscus*

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maniculatus and the latter as a parasite of the dusky-footed wood-rat, *Neotoma fuscipes.*

MATERIALS AND METHODS

Procedures for maintaining *Cuterebra* colonies were described by Catts (1964). In the laboratory, host animals were kept in appropriately sized metal boxes containing woodchip litter and covered with a lid of 9.7 mm mesh hardware cloth. Hamsters, *Cricetus auratus,* house mice, *Mus musculus* (laboratory mouse-strain C_3H/He Crgl), and laboratory rats, *Rattus rattus,* were fed rodent "checkers" (Purina Laboratory Chow, Ralston Purina Co., St. Louis, Mo.) and were given ample water. Native, wild rodent hosts, trapped from local areas, also were fed rodent checkers, but raw carrot roots were substituted for free water.

Unless other sites of entry were being tested, hosts were infected through oral or nasal routes. Infective larvae (1-3 days old) on the end of an applicator stick were offered to restrained or caged hosts. When the tip of the stick was touched to the nares, tongue, or lips of the rodent, infective larvae would actively transfer to the host and move into one of these moist openings. Thus positive entry of specific numbers of larvae were known. Often rodents voluntarily sniffed or licked the tip of the stick thus helping in the procedure. To test larval entry at other sites, hosts were anesthetized, first with ether fumes and then with an intraperitoneal injection of Nembutal Sodium (Pentobarbital Sodium, 60 mg/cc) at a dosage of approximately 0.1 ml/100 gms of body weight. After this infective larvae were placed on the test sites and their entry observed.

Histopathic study of the warble cyst wall was made by preparing frozen gelatin sections (10μ in thickness) (Lillie, 1956) of warbles from *Neotoma* with a 17-day-old infection. Sections were stained with Wright's stain.

For each host animal used in the laboratory, records were maintained showing: the general "thriftiness" of the animal, its weight changes the number and source of *Cuterebra* larvae introduced, the site of entry, the date of warble appearance, the time of each larval moult, the duration of infection, and the date of previous known infections.

Host animals were examined throughout the infection period from once or twice a week to several times each day, depending on the stage of infection. When the warble pore began to enlarge, hosts were placed over a 12.5 mm mesh, hardware cloth floor so that mature larvae would drop through this floor and thus reduced the chance that hosts would eat the larvae.

FINDINGS

Host specificity—Both *C. latifrons* and *C. approximata* demonstrated a strong degree of host specificity. Infective larvae of *C. latifrons* were introduced via oral and nasal routes into potential host species. Hosts were considered refractory if no signs of warble formation were found two weeks following infection. Various numbers of animals representing ten host species were tested. The following six species appeared refractory (the number of individuals tested is given in parenthesis): *Microtus californicus* (3), *Neotoma cinerea* (1), *Neotoma lepida* (6), *Peromyscus maniculatus* (10), *Reithrodontomys megalotis* (3), and *Oryctolagus cuniculus* (3). The remaining four species, including the natural host *N. fuscipies*, were susceptible, but the percent of exposures resulting in positive infection and the percent of introduced larvae completing parasitic development were very different for each (Table 1). Both hamsters and house mice also were susceptible to *Cuterebra* spp. normally occurring in brush rabbits (*Sylvilagus audabonii*) and deer mice (*P. maniculatus*). Although rabbits, *O. cuniculus,* were refractory to *C. latifrons,* they became infected when challenged with larvae of *Cuterebra lepivora* Coq., a bot fly normally occurring in brush rabbits (Ryckman and Lindt, 1954).

TABLE 1. SUMMARY OF LABORATORY INFECTIONS OF SUSCEPTIBLE RODENT HOSTS WITH THE BOT FLY, *CUTEREBRA LATIFRONS.*

Susceptible host species	Number of hosts in sample	Number of separate exposures	Number of bot larvae in infective dose[1]	Approximate percent of exposures resulting in positive infection	Approximate percent of introduced larvae completing parasitic development
Neotoma fuscipes[2]	13	25	2–3	92	67
Cricetus auratus	68	68	1	66	25
Mus musculus	40	40	1	50	0[3]
Rattus rattus	17	28	2–4	17	7

[1] Infection via oral or nasal routes.
[2] Native host for *C. latifrons.*
[3] All hosts died before larvae completed development.

Host susceptibility to *C. approximata* was tested with 25 *P. maniculatus,* 5 *Cr. auratus* 3 *N fuscipes.* The latter species proved to be refractory, and only 6.2% of 16 separate exposures of hamsters resulted in positive infection. In the natural host, *P. maniculatus,* 44% of 43 separate exposures gave positive infections and 26% of the total 93 introduced larvae completed development.

Influence of dosage level on larval success—The chance that any one larva would develop successfully in a susceptible host was influenced by the total number of larvae introduced into the host. As dosage levels (i.e.—the number of infective stage larvae) increased, the maximal and mean number of larvae completing development decreased. Woodrats, *N. fuscipes*, were infected with a single dosage of *C. latifrons* at levels of 2, 3, 5, 10 and 15 larvae per dose. At least ten animals were tested at each dosage level. Maximal, minimal and mean curves indicating the percent of success at each dosage level are given in Figure 1. The mean percent of larvae

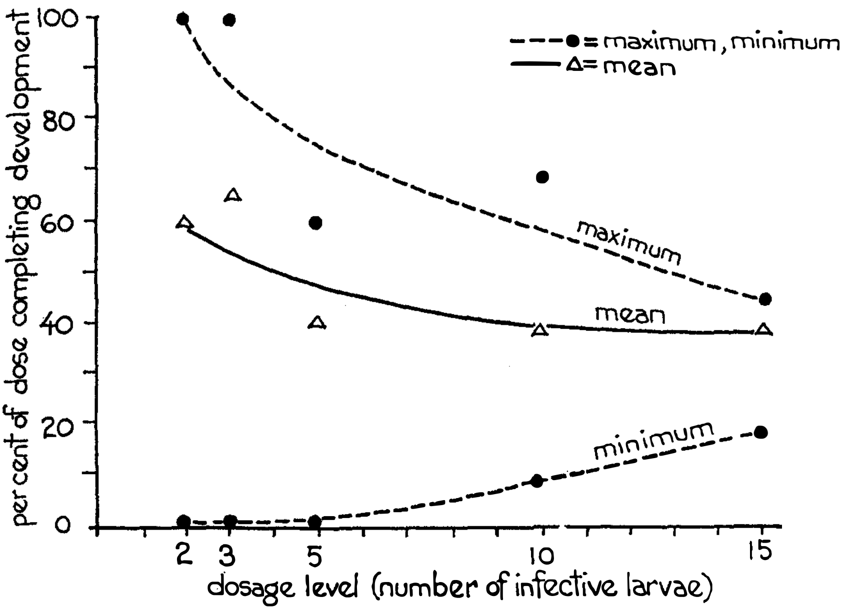

Figure 1. Percent of infective *Cuterebra latifrons* larvae, administered at different dosage levels, completing development in *Neotoma fuscipes*.

completing development was highest (66%) at dosage levels of three and lowest (40%) at levels of 5, 10 and 15 per host. Larger dosages of 10 or 15 larvae per woodrat resulted in positive infections in all but one host; this one animal died seven days after larvae were introduced. The maximal number of larvae maturing per animal was seven at the larger dosage levels.

Infective larvae of *C. approximata* were introduced into deer mice at dosage levels of 2 and of 3 infective larvae per host. At both levels, 33% of these infections resulted in development by a single larva. At a dosage level of two larvae, 11% of the infections produced a multiple infection. At a dosage level of three larvae, none of the infections were multiple.

Location of warbles—In their native host (*N. fuscipes*), nearly all (98.5%) of 193 *C. latifrons* larvae developed in warbles located in ventrocervical and upper sternal regions. There was no correlation between the entry site and the site of warble development; one perianally located warble in *N. fuscipes* developed after nasal introduction of infective larvae and all larvae gaining host entry by anal or genital portals produced warbles in the ventro-cervical region of woodrats. In hamsters, although most of a sample of 52 larvae developed on the anterior regions of the body, they were not as localized as those in woodrats. Only 25% were located in ventrocervical and sternal areas, and 69% occurred on the sides and top of the head. The remainder developed along the backline and flanks of hamster hosts. In contrast, most (73%) of 26 warbles produced in *C. approximata* infections of deer mice occurred in dorso-saccral and pericaudal areas. The remainder were on the posterior flanks of these hosts.

After reaching sites for warble development, larvae occasionally moved under the skin to a new site during the course of a single infection in hamsters, but this never occurred in woodrats or deer mice.

Influence of infection on the host—*Cuterebra* infection had different gross effects on host species. The total period for larval development in wild host species lasted from 28-38 days. In house mice, none of the hosts survived the 25th day of infection with either *Cuterebra* species although each mouse was supporting only one larva. In addition, none of these larvae formed a typical puparium; they all died soon after the death of their host. House mice continued to feed throughout the infection, but lost weight rapidly after the 12th day and died in an emaciated condition. Hamsters supporting infections of 1 or 2 *C. latifrons* larvae lost weight gradually throughout the infection. Woodrats with multiple infections of 2-7 larvae showed no distress and no continual loss in body weight during the infection. Although woodrats generally were 3 times the weight of hamsters, they were infected with greater numbers of bots. Some woodrats lost weight (15-20 gms) during the final 3-5 days of infection, but this change was not consistent enough to influence the mean weight values for all *N. fuscipes*.

Infected deer mice also gradually lost body weight particularly if they supported two larvae simultaneously. However there was no apparent decrease in host vigor or alertness until the last day of infection when the parasites began to back out of the warble-pore.

Death of the host terminated 3% of 94 separate woodrat infections with *C. latifrons* and 4% of 25 deer mouse infections with *C. approximata.* These mortalities occurred between the 7-10th day of infection in both host species. The animals died quickly with no prior signs of weakening or distress. All had hemorrhaged from the nose, but no cause for bleeding was found on post-mortem examination. There are two reports of death of hosts 6 to 7 days after the introduction of 12 to 22 infective larvae of another cuterebrid (Ryckman and Lindt, 1954; Penner, 1958). In both cases *Oryctalagus* was the host and there was no mention of distress by the infected animals prior to death. These times of death coincide with periods of first stage larval migration (Catts, 1963), suggesting the cause to be due to larval activities. The only possible temporary distress shown by infected rodents occurred about the seventh day of infection when audible wheezing by a few hosts was noted.

Death terminated 10% of 70 *C. latifrons* infections of hamsters, but this mortality occurred only after the 24th day of infection, before larvae had completed development.

Permanent unilateral impairment of locomotion resulted following infection of a few non-native hosts. Two hamsters (infected with *C. latifrons*) and one laboratory rabbit (infected with *C. lepivora*) were affected. The appearance of crippling occurred about the 7th day of infection.

Following the 10th day of infection in *N. fuscipes,* the skin area surrounding the warble-pore became denuded. This appeared due not only to stretching of the skin, but also to actual loss of hair. This did not occur in deer mouse infections. Warbles caused by bot larvae in native hosts (*Neotoma* or *Peromyscus*) had a well defined pore that was dry in appearance. In other susceptible hosts, such as hamsters or house mice, the denuded area and the pore were irregularly defined and the pore exuded fluids which kept the surrounding pelage wetted. After the larva dropped from a native host, the open warble collapsed within hours and healed rapidly over a period of several days. Healing was not as rapid in hamsters, requiring, at times, as long as 10 days.

Histopathology—In *N. fuscipes* the warble was a thickly-walled cyst opening through the epidermis and located within the corium of the skin. The wall of the cyst had a laminated gross appearance in sagittal sections (Fig. 2). In multiple infections of *C. latifrons* in woodrats, some adjacent larvae were in a common cyst. There was no well defined cyst formed in hamsters. Their warbles were composed of a gelatinous mass surrounding the larva.

The histopathic structure of the warble formed by *Neotoma* around

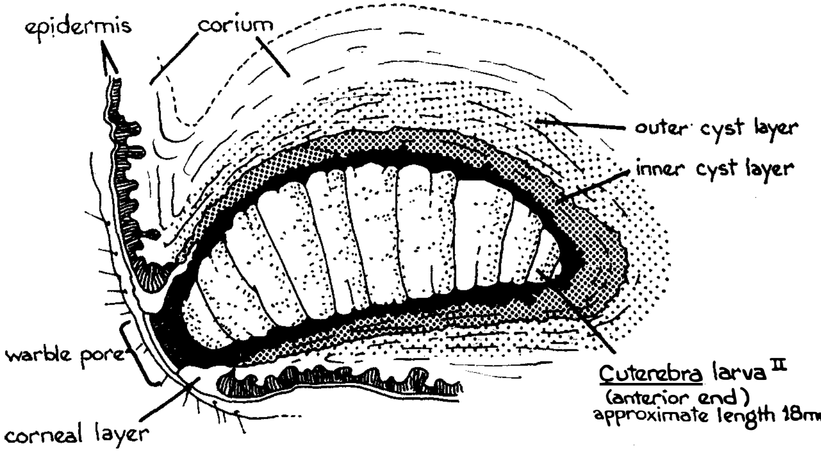

Figure 2. Schematic sagittal view of *Cuterebra latifrons* larva (II) *in situ* (host is *Neotoma fuscipes*).

larvae of *C. latifrons* is like that described by Bennett (1955) for warbles of chipmunks infected with *Cuterebra emasculator* Fitch. In *C. latifrons* infections the cyst wall appeared to be composed of two layers. The inner layer, lining the cyst cavity, consisted of dense collagenous material, containing disintegrated fibroblasts, histiocytes and a few intact erythrocytes. The second layer consisted of less dense collagenous fibers, numerous fibroblasts and scattered histiocytes intergrading into normal connective tissue. Sections showed the inner layer tending to separate from deeper cyst tissue, a feature noted by Bennett (1955). The inner cyst layer was thickest at the cephalic end of the larva and was similar in consistency with material in the alimentary tract of sectioned larvae. Possible increased activity in the production of connective tissue around the larva was indicated by many multinucleate fibroblast cells in the outer cyst layer.

Acquired immunity—The potential development of immunity by *N. fuscipes* was tested by repeatedly infecting individual woodrats with *C. latifrons* in the laboratory. Thirty woodrats were used in these tests and 70% of these animals were challenged at least three times. From a total of 94 separate exposures only nine negative infections were recorded. Seven of these negatives occurred in three woodrats. The first two of these animals showed positive infection after subsequent exposure, but the third woodrat appeared to have developed a solid immunity to *C. latifrons* after an initial heavy infection in which seven of 10 introduced larvae developed to maturity. All of the three additional attempts to infect this animal were unsuccessful.

Superinfection of woodrats was attempted: (1) by subjecting already infected hosts to one additional infective dose of larvae and (2) by introducing numerous repeated small doses of larvae at regular intervals. Attempts to superimpose infection with a single additional dose of larvae in animals already supporting larvae were successful in nine of ten trials. Small numbers of larvae introduced into woodrats at 1-2 day intervals for a 2-4 week period also generally were successful. Although a large number of these larvae did not become established in skin sites the number which did develop was comparable to that expected for a single massive dose of larvae. No attempt was made to transfer immunity artificially as the primary objective was to investigate the potential development of immunity in nature.

Predation—*Cuterebra latifrons* larvae inside of the warble apparently were ignored by the host. One woodrat repeatedly licked the mass of warbles located between her forelegs, but made no attempt to bite the parasites. While they were being watched or handled woodrats or deer mice paid no obvious attention to larvae which, in the process of emerging, were protruding from the warbles. On numerous occasions dropped larvae were found crawling about over surface litter near the host. However, before infected woodrats were suspended on wire floored cages (so that dropped larvae were protected from foraging by the host) 56.6% of 53 full-term larvae could not be found after they left the woodrats. Only 12% of 141 full-term larvae were lost after these holding cages were put into use. Occasionally, the cuticular remains of larvae were found in the cage litter. Remains of puparia were not found.

Even when held on wire cloth, individual woodrats differed in their tendency to eat dropped larvae. One animal apparently ate all of five larvae that dropped from it following separate infection periods. Another consumed eight of ten larvae. Conversely, all eleven larvae produced over four infection periods in a single woodrat were recovered.

Dropped larvae displayed a characteristic behavioral response which may decrease the chance of predation. When molested by probing, squeezing or handling, these larvae contract their segments into a more compact form and remain motionless for 2-3 minutes.

DISCUSSION

In general these findings emphasize the complexity of the host-bot fly association involving a high degree of host tolerance on which the parasite is dependent for successful larval development. The general refractoriness of New World host species to infection by *Cuterebra* normally parasitizing other such rodents and the general susceptibility of Old World rodents to *Cuterebra* infection both concur with findings of other studies (Penner and Pocius, 1956; Radovsky and Catts, 1960). Further, the susceptibility of such rodents as *Cr. auratus, M. musculus* and *R. rattus* does not confirm their suitability as a host. The detrimental effects of infection in these hosts were in contrast to all apparent effects on the native host. In *Cricetus,* movement by developing larvae after they had once reached a potential warble site may result from poorly defined cyst development. The net production of fully developed larvae by susceptible Old World rodents was low in comparison to that of native hosts infected with the same *Cuterebra* species. Indeed, this suggests that the wide range of non-rodent hosts reported for *Cuterebra* species are not suitable hosts in the sense that they produce few, if any, mature larvae. The overall benign character of *Cuterebra* infections in the native host species further supports this distinction between susceptibility and suitability of host animals.

Cuterebrid bot flies occur only in the New World, so Old World rodent species lack phylogenetic experience with these parasites. All of these facts indicate that this rodent-bot fly association reflects a long history of symbiosis where the host and parasite, in their behavior and interactivities, are selectively adapted to each other.

There has been scant evidence of resistance to *Cuterebra* infection in susceptible wild host populations. In their study of the dusky-footed woodrat, Linsdale and Tevis (1951) indicated that higher incidence of infection among younger woodrats was the result of some 'defensive mechanism developing" in older animals. Bennett (1955) found a significantly larger number of adult chipmunks infected and believed this was due primarily to host behavior. Wecker (1962) found that almost half of the infected white-footed mice examined were parasitized more than once during one season.

Cuterebra lay eggs in small groups, of 5-15 eggs each, in the vicinity of the host's normal activities (Painter, 1930; Beamer, 1950; Catts, 1963). After maturing these eggs hatch in response to a sudden slight increase in temperature (Catts, 1963). Such a condition occurs when a warm-blooded animal is near the eggs.

Numbers of *Cuterebra* larvae in woodrats on the Hastings Reservation (Monterey Co., Calif.) reach seasonal peaks in April-June and in October (Linsdale and Tevis, 1951). The spring peak occurs several weeks before adult bot flies are active and at least one month before progeny of the spring brood of flies appear in woodrats (midsummer) (Catts, 1963). *Neotoma fuscipes* populations are relatively stable with little extensive movement by individuals (Linsdale and Tevis, 1951), but seasonal activities of these hosts (not their acquired immunity) could account for the spring peak in infections. Host sexual activity occurs from January through April, with its greatest intensity in March; most pregnancies occur from February through April. Woodrats trapped at Hastings had a higher percent of infection in adult and subadult males than in similar female age groups (males were 15-20% higher). During the mating season male woodrats move frequently from female to female, each in her own house, increasing the chance of male infection over the more sedentary females.

Linsdale and Tevis (1951) further report that during May, nearly all immature woodrats were infected. Young woodrats leave the maternal house when they are about 25 days old and move to the nearest unoccupied house. Litter mates compete with established adults and with each other for empty houses and, in this way, many of them move about considerably, investigating strange houses, before they become settled (Linsdale and Tevis, 1951). Because these houses serve as egg-laying sites, this behavior would tend to subject young woodrats to a greater chance of exposure to unhatched bot fly eggs.

In this study, attempts to induce natural immunity by repeated infections were not successful, with the exception of one animal exposed to a massive dose of ten larvae. Those ages and both sexes of rats challenged proved repeatedly to be susceptible. Apparently, the spring peak in infections reported by Linsdale and Tevis (1951) is due to seasonal behavior of woodrats making them subject to exposure to unhatched *Cuterebra* eggs which have overwintered. This concurs with Bennett's (1955) conclusions with respect to chipmunk infections by *C. emasculator.*

The October peak in *Cuterebra* infections probably is the result of steady seasonal increase of ovipositing flies and of increasing numbers of viable eggs around woodrat houses (Catts, 1963). Peak fly populations in midsummer would initiate increase in *Cuterebra* infections during October. Such was the case reported at Hastings Reservation (Linsdale and Tevis, 1951).

Broadly speaking, resistance includes any activities of the host which decrease the chance of successful infection or development by the parasite. Predation of bot fly larvae by their rodent hosts is such an activity. Woodrats generally are active continually when outside the protection of their houses. Apparently mature larvae tend to drop when the host is active (Catts, 1963), and such a behavior would scatter mature larvae in the chaparral area surrounding the house. Nocturnal habits of *Neotoma* (Linsdale and Tevis, 1951) decrease the chance that dropped bots may become prey for insectivorous birds. The greatest danger probably is from the host itself, although other insectivorous animals (skunks, shrews and deer mice) forage in the same areas at night. *Neotoma* hosts, outside of a house, may ignore larvae that drop from them and would not be in one place long enough to destroy the parasite, but movements of dropped larvae inside of the house probably would receive closer attention. Predation of mature larvae by confined *Neotoma* in the laboratory tends to support this reasoning. Perhaps the burrowing habits of prepupal larvae and their lack of obvious movement just prior to pupation, tends to make larvae which are buried or which have formed puparia less subject to predation by foraging woodrats. This suggests the importance of an environment suitable for pupation. Under unfavorable conditions (i.e.—lack of surface cover, or of soil moisture) dropped larvae tend to move about for a longer period, increasing the chance of predation.

Two general aspects of adaptation are illustrated by these studies; one involves the rodent host, the other involves the parasite. First, in order to acquire a specific rodent host and in order to decrease the chance of larval destruction through predation on leaving that host, the behavior of the parasite must adapt to that of the host. Second, the native rodent host displays a high degree of adaptive tolerance to the effects of parasitic larval development.

SUMMARY

Studies were made of laboratory infections of various rodent species with cuterebrid bot flies (Diptera, Cuterebridae).

The bot fly species studied showed a high degree of host specificity. Larvae of *Cuterebra latifrons* and *C. approximata* were introduced into various wild and laboratory rodent animals. Few larvae completed their development except when infecting their native host species. New World rodent hosts demonstrated a high degree of refractoriness to *Cuterebra* species infecting other rodents. Old World rodents were generally susceptible.

Larval warbles were located in characteristic body regions on their native host, but were less localized on other rodents. Also, warble cysts were well defined in native hosts, but not in other rodents. Host weight changes indicated greater pathological effects on non-native hosts.

Attempts to induce immunity in individual native hosts through repeated infections or heavy infective doses of larvae were not successful. During any one year, fluctuations in bot fly parasitism in nature appears to reflect the size of the bot fly population and

seasonal behavior of the host rather than immune resistance in the host population.

This interrelationship reflects adaptation of the parasite's behavior to that of specific rodent hosts and a high level of host tolerance to the effects of parasitic larval development.

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DISCUSSION

LT. R. L. RICHARDSON [Armed Forces Institute of Pathology]: Is your definition of a bot fly larva an endoparasite or ectoparasite? I have had discussion on this before.

DR. CATTS: I am not going to attempt to answer that. This is just a question of a definition as to what we want to call it. At certain times in its life history it is more an endoparasite than an ectoparasite. The larva stage migrates through the deeper tissues once it enters the host. It enters always through the moist body openings, at least the species I worked with, although Penner has shown there are some which can directly penetrate the skin. But this still requires a migrating phase in deeper tissues and then it remains in the superficial tissues within the skin, not beneath the skin, as it completes its larva development. I think I have successfully evaded that question.

MR. PHILLIPS [Rocky Mountain Laboratory]: A few years ago we were in Northern Nevada investigating a peak population of jack rabbits, and we wanted to be on hand to see if we could observe the crash when it happened. Incidental to that, it was suite obvious the *Cuterebra* had also attacked the rabbits and some of the infestations were unbelievable. From eight to ten bots in various stages of development would be in the head of one rabbit. Sometimes they were just pouches of skin, and it must have been extremely excruciating. These infested animals would be wandering around in the daytime paying no attention to predators or anything. We got some pictures of these bots. This was an infestation that obviously had built up with the rabbit population itself because, after the crash occurred, the next year I was there I found very few bot-infested rabbits.

MR. JACK QUINN [Virginia]: We have noticed a build up in the gray squirrels from one year to another and I wondered if you had any information on population density work with these and under what conditions you might have noticed an effect on the population?

DR. CATTS: No, I have not. There has been attempts to do this, to relate climatic factors with possible build up of the bot fly populations. I believe Delmat suggested that a crash in the population of deer mice preceded heavy seasonal instance of *Cuterebra.* But I think from what I have found in my own studies of *Cuterebra* that we have to have a more thorough knowledge of the biology of the bot fly before we can suggest what is causing seasonal fluctuations in the bot fly in the particular host.

AN APPROACH TO THE PATHOGENESIS OF VIRAL HEMORRHAGIC DISEASE OF DEER

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Epizootic hemorrhagic disease (EHD) of specific viral etiology was first described by Shope (1955) from an epizootic in white-tailed deer (*Odocoileus virginianus*) in New Jersey. Laboratory-confirmed cases have subsequently been reported from Michigan (Fay *et al.*, 1964), South Dakota (Shope *et al.*, 1960) and Alberta (Chalmers *et al.*, 1964). The outbreak in Alberta involved mule deer (*Odocoileus hemionus*) and pronghorn antelope (*Antilocapra americana*) as well as white-tailed deer. Outbreaks of similar disease have been reported from other states but the etiological agent(s) have not been identified. Shope *et al.* (1960) demonstrated two serologically distinct strains, designated New Jersey and South Dakota. Ditchfield *et al.* (1964), using the Alberta isolate, found the virus to possess the properties ascribed to the Picornavirus group, particularly the encephalomyocarditis viruses.

The epizootiology of EHD is at present unknown. The occurrence of infrequent epizootics of EHD in widely scattered areas of the North American continent gives cause for enquiry into the interepizootic survival of the virus. Characterization of the virus as having properties similar to the encephalomyocarditis group gives rise to speculation on the possible occurrence of silent reservoirs, such as rodents or pigs. This has led us to begin experiments designed to elucidate the natural history of this virus in deer and other possible hosts.

In the course of these investigations we have had an opportunity to study the pathogenesis of EHD in deer. This paper deals with our observations on experimentally infected deer.

MATERIALS AND METHODS

The virus used was obtained from the spleen of a naturally infected mule deer received from Dr. H. N. Vance, Department of Agriculture, Province of Alberta. This was found to be the New Jersey serotype of virus (Ditchfield *et al.,* 1964).

The deer used were native Ontario deer captured in the wild or captive deer from various locations in the Province. All were kept in an enclosure at the Veterinary College in Guelph. All animals were apparently healthy before experimental inoculation.

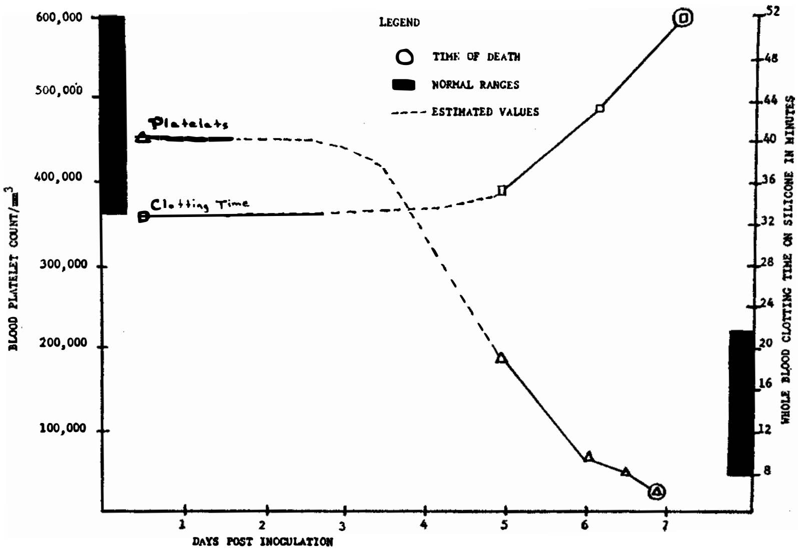
Blood coagulation studies were made on healthy and infected deer. Platelet counts were carried out on venous blood by the method of Brecher *et al.* (1953). Whole blood clotting time (WBCT) on glass was measured by the method of Dale and Laidlaw (1911). The WBCT on silicone was measured by the method of Lee-White as described by Hjort and Stormorken (1957). The one-stage prothrombin time (OSPT) and Russells' viper tests (RVVT) were carried out using standard techniques described by Biggs and MacFarlane (1962).

Eight apparently healthy deer were tested to determine the blood values that were taken as normal for the purposes of this study. All deer inoculated were tested before exposure to the virus. The ranges for these tests were found to be:

(1) platelet count—380,000 to 665,000/mm^3 (mean: 512,000/mm^3)
(2) WBCT—on glass—6 to 10 minutes (mean: 8.3 minutes)
—on silicone—9 to 22 minutes (mean: 16 minutes)
(3) OSPT—18 to 22 seconds (mean: 21 seconds)
(4) RVVT—25 to 39 seconds (mean: 29.8 seconds)

Complement fixation tests (CF) on blood serum were conducted using an antigen made from suckling mouse brains, constituting the 15th serial passage of the Alberta strain of EHD virus. Two-day-old white Swiss mice (strain CFW obtained from Carworth Farms, Carworth, New Jersey) were inoculated intracerebrally and brains were harvested when the mice were moribund 3 to 5 days later.

Gross and microscopic examinations were made of the tissues of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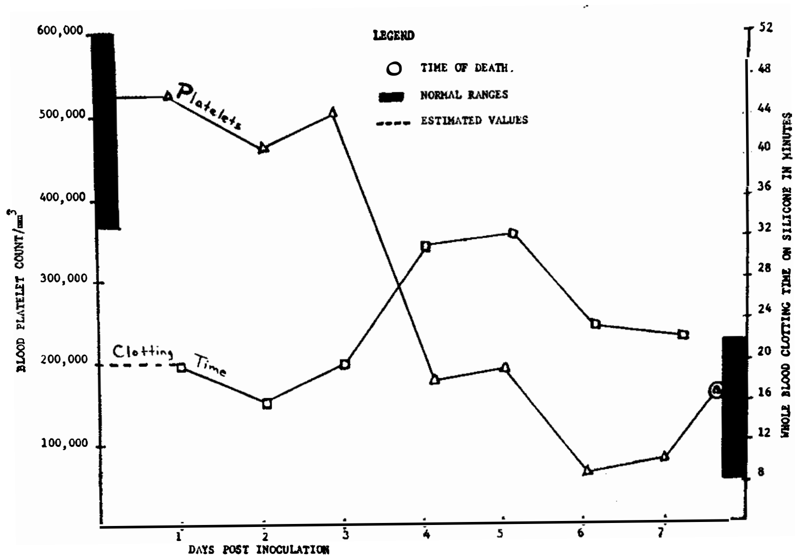
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each animal. Necropsies were performed either immediately after the infections terminated in death or after euthanasia. Histopathologic examinations were made on formalin-fixed, paraffin-embedded tissue sections, stained with hematoxylin and eosin.

The tissue culture system employed was L-929 mouse fibroblast cells maintained in Eagles' Minimum Essential medium with 10% fetal calf serum added.

RESULTS

Susceptible deer, when inoculated either intramuscularly (IM) or intravenously (IV) with 10% suspensions of spleen of EHD infected deer, usually died within eight days. On one occasion, a deer took 12 days to succumb. This however, was the result of an overwhelming challenge of an animal which had recovered from an earlier experimental infection.

Body temperatures generally increased 2-3 days before death. Age of the animal did not appear to alter the results.

Blood coagulation studies revealed that platelet counts began to fall on the fifth post-inoculation day (PI). The decrease in platelets was quite rapid. Generally 36 hours before death the platelet count was around 200,000/mm^3 and twelve hours before death the count was near 100,000/mm^3. Definite weakness was not noticed until the platelet count was below 50,000/mm^3 and counts as low as 30,000/mm^3 were measured before death occurred. Occasionally, platelet counts would drop to around 100,000/mm^3 24 hours before death and then begin to rise, continuing to increase up to the time of death. Figures 1 and 2 graphically portray these 2 types of platelet response.

Deer that were inoculated with EHD virus but did not die were found to have platelet counts in the range of 100,000/mm^3 on PI5 to PI6, but these counts returned to normal within 48 hours. When challenged later with overwhelming dose of virus, two such deer developed thrombocytopenia under 50,000/mm^3 before dying. The immune deer that died 12 days after challenge was found to have a platelet count of 120,000/mm^3 on PI8. A few hours before death its platelet count was 30,000/mm^3.

Measurements of whole blood clotting time were performed on glass and on silicone. All infected deer had an increase in clotting time on silicone ranging from 35 to 58 minutes, one to three days before death. Deer that recovered from infection had lesser increases in the clotting time on silicone during the period that the blood platelet counts were decreased. The clotting time on glass was often within the normal range when other coagulation values were abnormal. We have never seen the clotting time on glass increased beyond 15 minutes and, when it did increase, it was at the time of the lowest platelet count. In deer that recovered, the clotting time on glass returned to normal before the clotting time on silicone.

The one stage prothrombin clotting times were often found to be within normal range when other tests indicated a breakdown in hemostasis. In two deer, OSPT were found to be increased to 40 seconds or higher two days before death and remain high until death.

The Russells' viper venom clotting times increased as the platelet counts decreased in all deer infected with EHD virus. The increased values were in the range of 40 to 50 seconds.

At necropsy, hemorrhages were usually visible grossly in most organs of the bodies of infected deer. On occasion however, hemorrhages were confined to the heart and portions of the alimentary tract.

On histopathological examination, the lesions described by Shope (1960) and Karstad *et al.* (1961) were regularly seen. In addition, some deer had subacute to acute enteritis with submucosal edema and muscular degeneration. Infarcts were observed in the heart as well as medial degeneration and hemorrhages in the aorta. Multiple myocardial infarcts associated with marked proliferative vasculitis, a lesion not previously noted in EHD, were observed in one deer. Two deer had apparent axon degeneration and demyelination seen in hemotoxylin and eosin stained sections of the brain. Two other deer had hemorrhages, glial karyorrhexis, perivascular edema and areas of softening in the brain.

A deer which had been exposed to the virus of EHD by stomach tube and subsequently survived three challenge inoculations of EHD virus was euthanized. At necropsy, the only gross lesions found were enlarged mesenteric lymph nodes and congestion of the cerebral blood vessels. On histopathological examination brain lesions were seen which consisted of glial nodules associated with blood vessels and proliferation of perithelial cells around venules. Slight periarteritis was present in some of the medium sized arteries of the kidneys. There was vasculitis of small vessels in the wall of the aorta and the pulmonary vein had some subintimal necrosis. Cellular infiltration around some small vessels in the lung and myocardium also were observed.

A female deer, in her fifth month of pregnancy, was dosed by stomach tube with 50cc of a 10% spleen suspension known to contain EHD virus. The deer showed no abnormal signs until the second week after inoculation, when a decrease in appetite, conjunctivitis, and hyperemia of the vulva were noted. These signs disappeared in a few days. At this time the dose of succinylcholine chloride required to immobilize this doe was decreased by 50%. The doe gave birth to a male fawn two months later. Complement fixing antibodies to EHD, at a 1/64 dilution, were observed in the doe at the time of parturition but CF antibodies were not demonstrable in the fawn at nine days of age. This fawn appeared normal until 7 days after birth, at which time it would not or could not nurse. Despite bottle feeding and glucose administration, the fawn died at 9 days of age. All tissues appeared normal at necropsy. Perivascular hemorrhages in the gray matter of the spinal cord and the base of the brain were the only lesions found on histologic examination. A pool of tissues from this fawn did not cause observable disease in a deer inoculated intramuscularly.

One deer was exposed to EHD virus by aerosol. No temperature elevation or other signs of disease were subsequently noted. No CF antibodies to EHD were found in serum collected one, two and six months after exposure.

A total of seven deer, experimentally exposed to EHD virus, were tested for production of CF antibodies. The pre-exposure sera were negative in all instances. Only two deer responded with CF titres at maximum serum dilutions of 1/64 and 1/128, respectively. In at least two of the remaining five animals, disturbances in blood coagulation indicated that infection had occurred.

Repeated attempts were made to recover virus from blood and fecal samples in L-cells. Cytopathic effects were observed in several instances but in no case was it possible to prove that these were due to the specific effects of the virus.

DISCUSSION

The occurrence of hemorrhages associated with vascular lesions was prominent in all the deer infected with EHD. Kartsad *et al.* (1961) found that deer infected with EHD had prolonged blood coagulation and prothrombin times, suggesting derangement of the normal blood clotting mechanisms.

The arrest of hemorrhage depends on three main factors: (1) the wall of the blood vessel; (2) the blood platelet and (3) blood coagulation. A derangement of any or all of these factors results in hemorrhage.

In our studies, we have observed a decrease in blood platelets in the peripheral blood of deer exposed to the virus of EHD, even in animals that showed no clinical signs.

As outlined by Rowsell and Mustard (1963), blood coagulation is basically the conversion of prothrombin to thrombin. Thrombin is an enzyme which converts fibrinogen, a sol, to fibrin, a gel, and the blood is then said to clot. A delay or reduction in formation of thrombin leads to a prolonged whole blood clotting time. In deer exposed to EHD a prolonged blood clotting time was seen to occur on silicone. Some of these deer, however, were observed to have clotting times on glass within normal limits. This test is very sensitive to the accidental introduction of tissue juices, as in taking a venous blood sample. This may be what is involved in these results since, with the limited number of animals studied, increased clotting times on glass did occur in some deer. The silicone method is widely used to minimize the effects of such accidental admixture of blood and tissue juices. We believe, therefore, that our measurements of clotting times on silicone present a truer picture of the abnormality.

Russells' viper venom test employs the venom as a substitute for tissue thromboplastin. It is a measure of blood platelet loss, prothrombin lack, Factor V and Factor X (Biggs and MacFarlane, 1962). In all the deer that showed a thrombocytopenia, an increase was also seen in the Russells' viper venom clotting time. In the one-stage prothrombin test, brain extracts are used as a source of tissue thromboplastin. It is similar to the Russells' viper venom test but in addition it also measures Factor VII. Some deer, but not all, developed an increased one stage prothrombin clotting time. From these results, the virus of EHD can be said to definitely affect the hemostatic mechanism by causing a decrease in the blood platelets. The question remains, however, whether or not any deficiency in the blood Factors result from exposure to EHD virus. This can only be done by blood Factor assays. These we are preparing to do on additional infected deer.

The third factor in hemostasis, integrity of the blood vessel wall, may also be involved in the pathogenesis of EHD.

The earliest damage to blood vessels walls has been difficult to demonstrate by light microscopy. The electron microscope may reveal lesions, though minor, which may be partly responsible for the hemorrhages observed. Minor endothelial damage may be responsible for taking platelets rapidly out of circulation, since it seems unlikely that the very rapid reduction in platelet counts seen is due to failure of platelet production. We *have* demonstrated later stages of vascular lesions. These consist of proliferative or repairative changes in vessel walls, most marked in the heart and in the brain. Such lesions have been found directly associated with myocardial infarcts and areas of cerebral softening or glial proliferation. These proliferative vascular lesions were most marked in animals which survived longest and in which myocardial damage appeared to be the terminal cause of death. In two such cases the derangement in blood coagulation had passed its peak at the time of death and the animals appeared to be recovering (i.e. platelet counts were rising and whole blood coagulation times were decreasing).

We have found that some deer which have shown a blood coagulation response to exposure to EHD virus have continued to show negative CF tests. When a deer responded with a CF antibody titre, the test was a useful tool. Some deer, however, failed to respond with positive CF tests after exposure to EHD so that the test cannot be used with certainty in establishing that a deer has been infected. The CF test has been used for detection of antibodies to anaplasmosis but the titers observed disappeared rapidly after exposure (Osebold *et al.,* 1959).

Serum neutralization tests using HeLa cell cultures were successfully carried out by Mettler *et al.* (1962). Cytopathic effect (CPE) was observed about the 14th day. Preliminary investigation last year led us to suspect that L-cells would show CPE in a shorter period of time. On further work with this cell line, we have found that primary isolation of EHD virus is difficult. While in some cases, CPE is seen in 3 to 4 days after inoculation with material containing the virus, more often no CPE is seen. Therefore, the use of L-cells for primary isolation or titration of EHD virus has not been satisfactory.

Many avenues remain open for research on EHD. The importance of the disease, beyond its devastating effects on a susceptible deer herd, lies in its value as a model for the study of other hemorrhagic diseases, especially the viral hemorrhagic fevers of man. We have attempted to show its potential as a model for studies of irregularities in hemostasis.

SUMMARY

A definite decrease in blood platelets has been found in white-tailed deer (*Odocoileus virginianus*) experimentally infected with the virus of epizootic hemorrhagic disease (EHD). Histopathological evidence is also given suggesting involvement of the blood vessel wall.

Complement fixation serological tests appear to be unreliable in testing antibody to EHD.

The L-929 mouse fibroblast tissue culture cell line does not appear to be a suitable system for the primary isolation of EHD virus.

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DISCUSSION

DISCUSSION LEADER HERMAN: This paper is now open for questions.

DR. TRAINER (Wisconsin): I have just one comment and one question, the comment being that there have been laboratory confirmed isolations of this from Nebraska and North Dakota as well as these. In fact we are quite sure it is the same serotype as the New Jersey or the Alberta you are working with.

The question I had was, in our studies we find a great deal of variation as far as gross pathology is concerned, and I was wondering what the number of animals you used in your histologic study was and how consistent the findings were? We find much variation.

MR. DEBBIE: First of all, we used a total of 13 animals. I probably forgot to mention that we also find a lot of variation in gross pathology. Often you will find no hemorrhages other than myocardial hemorrhages. This seems to be the one thing that is consistent. You may find some enteritis. We also find histopathologically, and grossly too, acute and subacute enteritis. We get an animal that you would not consider EHD when you first open him up, because the lesions are very scanty, while in other animals, you find hemorrhages in practically every tissue of the body.

DR. PHILIP: Has tick transmission been done?

MR. DEBBIE: I believe some work has been done. Dr. Trainer might be better able to answer that. I believe Dr. Shope worked with ticks, and you did, too, didn't you?

DR. TRAINER: We tried it without any success.

MR. DEBBIE: This brings up the important fact that very little is known about the epizootiology of this disease. One thing we would like to bring out in this paper on pathogenesis is that we may be able to have at least a model for other types of hemorrhagic diseases, besides the devastating effect that the virus has on deer. It can become a good laboratory animal for the study of some hemorrhagic diseases.

THE USE OF EXPLORATORY SURGERY TO MEASURE PRODUCTIVITY IN A POPULATION OF MAMMALS

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INTRODUCTION

The density of an animal population at a given moment is a result of its previous history of births, deaths, and movements. Thus it is important to measure these three forces and the environmental factors influencing them. This report concerns only measurement of births. Since it is usually impossible to count young animals at the time of birth before death affects their numbers, a closely related index of productivity is often measured—the number of embryos or embryo scars in the mother's uterus. Usually these are counted at autopsy, which, of course, eliminates the autopsied females thus affecting the population dynamics.

The purpose of this paper is to describe the seldom-used technique, exploratory surgery, for measuring productivity in a living population; to report an experimental test of the side effects of the surgery; and to report the productivity, so measured, in a population of the California Ground Squirrel, *Spermophilus beecheyi*.

Exploratory surgery has many uses other than measurement of productivity, e.g., pathology surveys, examination of organs such as spleen, adrenals, testes, and ovaries, and observation of fat deposits. Yet this technique has been little used by populations analysts. Macfarlane, Pennycuik, and Thrift (1957) used laparotomy to determine embryo numbers in laboratory rats. Dr. Glen C. Sanderson (personal communication) reports satisfactory results from extensive exploratory surgery on raccoons. Neither MacFarlane, *et al.*, nor Sanderson has reported explicit studies of the effects of the operation on fetal and maternal morbidity and mortality, and on subsequent reproductive rates in the operated females.

SURGICAL TECHNIQUE

This is the technique as we currently practice it.

Anesthetize subjects with ether; administer first in a face mask made of a small tin can packed with cotton in the bottom. Then maintain anesthesia using a paper-enclosed cotton mask onto which ether is poured as needed. When the subject is fully anesthetized, place it on its back on an operating board and restrain it with rubber bands, one on each foot and one over the upper incisors. Bathe the belly with refined benzalkonium chloride (brand named, Zephiran). This antiseptic and germicide is the only precaution used against infection. Since the technique is for field use with the fewest possible supplies and equipment, we avoided extra precautions, such as antibiotic injections, to test the practicability of septic surgery. Shave all hair from the lower belly with a single-edge safety razor blade without a holder.

Make a mid-line skin incision about 45 mm. long, extending forward from the pubic bone, with a razor blade or scalpel. Separate the longitudinal muscles with a blunt probe, and cut the peritoneum. Then place cheesecloth operating sheet, wrung out in the antiseptic, over the operating area, leaving the incision exposed in a rectangular hole in the cloth. This provides a clean surface on which to lay the uterine horns, instruments, and sutures.

Tilt the urinary bladder out and lay it on the cloth above the external genitalia. Lift one of the uterine horns out and count the embryo bulges or scars. Replace it and similarly examine the other horn. The uterine mesenteries are sufficiently broad to allow the horns to be withdrawn from the body cavity without tearing.

After the uterine horns and bladder are replaced in their correct positions in the body cavity, suture the incision. First, sew both the peritoneal lining and the epimysium of the abdominal muscles together with a single, spiral-stitch closure. If the entire body wall is lifted by forceps at the two ends of the incision, the peritoneal lining and epimysium stand out as ridges which are then easily sewn together across the incision. Next using cotton or silk sutures, sew the skin using a "mattress stitch" (Figure 1). Insert the needle (a three-cornered, slightly curved cutting needle) from the outside to the inside of the skin on the right side of the incision, across the incision and from inside to outside the skin opposite. Now drop down the incision about 5 mm. and reverse the course: outside to inside of the skin to the left of the incision, then inside to outside to the right. Bring suture back to the point of beginning and tie a square knot beside the incision, not over it. In closing the incision draw the suture just tight enough to bring the skin together into a slight bulge like pursed lips. Do not cinch too tightly. Place additional mattress stitches along the incision until it is closed.

Finally bathe the incision with antiseptic and return the squirrel

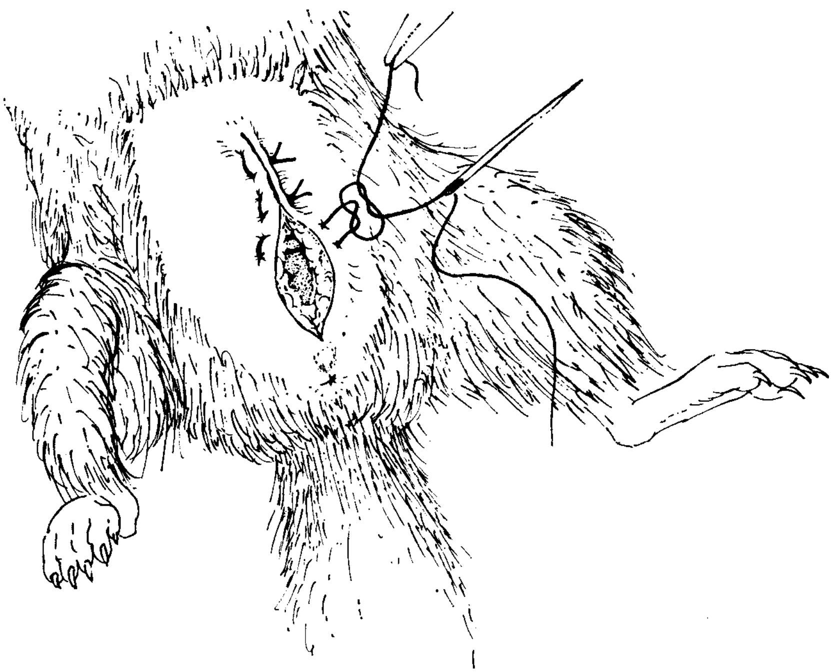

FIG. 1. Closing the incision with a mattress stitch as described in the text.

to its cage (or burrow). Recovery from the anesthesia takes only five to ten minutes.

SIDE EFFECTS OF SURGERY

Procedure. When surgery is contemplated, the question arises whether the surgery will affect the animals' survival, health, and reproductive powers. We therefore experimented with captive animals to test the effects of surgery. From February 21 to June 15, 1962, 81 female ground squirrels were captured on the Hastings Reservation (Linsdale, 1946, p. 3) and on adjacent ranches. Shortly after capture, 40 of these females were operated upon. Forty-one were untreated. All were kept in captivity for varying lengths of time to observe survival, parturition and health of the operated animals compared with those of the control group. Animals to be operated upon were selected by restricted randomization. In order to compare treated and control animals caught at about the same time, each four females caught in any one trapping sequence were grouped and two were chosen at random for operation. The squirrels were kept in cages, one per cage, and fed daily rations of commercial laboratory rat food and water. They ate well and adapted readily to captivity. Observations were made almost daily on survival, births, and health of the squirrels.

Results. The status of the 81 experimental females is shown in Table 1.

TABLE 1. NUMBER OF SQUIRRELS IN VARIOUS SURVIVAL CONDITIONS 45 DAYS OR MORE FOLLOWING SURGERY.

Status	Operated	Unoperated
Living in capitivity	18	19
Escaped	6	3
Sacrificed	4	10
Died in captivity	12	9

Healthy animals which escaped or were sacrificed more than 45 days after surgery may be considered survivors from the effects of surgery. In Table 2 these are grouped with those in the category "Surviving."

Discussion. The operative technique is designed for field use where squirrels will be live-trapped, operated upon, and released immediately. The effects of operation on captive animals cannot be used directly to predict the effects on animals released after operation. In the initial development of the technique we kept the squirrels in captivity in order to observe more closely the effects of the operation. Later we will study effects under field conditions.

Our lack of surgical skill unavoidably affected our experimental results in the early part of the experiment. We had greater success as our experience progressed. The possible effect of our developing facility is confounded with the effects of changing conditions of the squirrels. Therefore the respective effects are evaluated in informal fashion which will be explained.

TABLE 2. NUMBER OF SQUIRRELS SURVIVING OR DEAD 45 DAYS OR MORE FOLLOWING SURGERY.

Status	Operated	Unoperated
Surviving	22	22
Dead	12	9

Statistically, there is no significant difference in survival between operated and unoperated animals (Table 2). Although it might therefore be concluded that the surgery does not affect survival appreciably, it is known that some of the deaths in operated animals resulted directly from the surgery. It is informative to review these cases. Of the 12 operated animals that died in captivity, one died of causes unrelated to surgery, 3 of unknown causes, 2 of anesthesia during the operations, and 6 of surgical complications. If we assume that all the deaths attributable to surgery are included in the last two categories, we have 8 such deaths among the 40 operated squirrels. A technique which imposes such a mortality rate (20%) cannot be used on a live population. However, all 8 deaths attributable to surgery occurred in the early part of the program before we gained facility in the technique and among the first 18 animals operated. None occurred among the remaining 22 squirrels operated.

Causes of the surgically-induced deaths were—anesthesia and suture failures. Besides the two animals that died of anesthesia during surgery, squirrels used in other experiments have died while under ether. This results partly from the surgeon's also being the anesthetist (to minimize manpower required for the technique), which results in over-anesthetization during periods when attention is diverted from anesthesia to the operation. Also some squirrels are especially susceptible to ether death. We plan to explore other anesthetics to reduce the number of deaths.

Suture failure results in ruptured incisions. Our earlier mistakes were inserting the suture too near the edge of the incision and pulling the suture-loop too tightly together. Also sutures were sometimes too far apart. When we corrected these errors and substituted the mattress stitch for the single stitch, the incidence of ruptured incisions fell to zero. Sutures should be inserted about 3.5 mm. from the edge of the incision and about 4.5 mm. from each other. The two legs of the mattress stitch should also be about 4.5 mm. from each other.

Sub-lethal post-operative pathology would be of interest if it affected population dynamics. For example, if a female's reproductive capabilities were curtailed by the operation, either temporarily or permanently, it could make use of this technique inadvisable. We have watched for indications of such complications. Swellings around the incision occurred after a few of the earliest operations which appeared to be results of infections. This did not occur after the few early operations and is therefore considered unimportant. A more serious occurrence is uterine adhesions. In eight post-operative examinations we found two cases of adhesions. In one, one horn had adhered to a ventral muscle. In the other, the uterine horn folded upon itself and adhered. This probably could affect current or future pregnancies. We are planning further observations to determine the incidence and possible preventatives of adhesions.

We have not yet observed the effect of post-parturition surgery on the nursing of young. It seems likely that the mother might avoid nursing her young after surgery, or, if permitted, the nursing might cause surgical complication such as ruptures or infections.

The time required for surgery depends upon experience of the surgeon. The least amount of time we have taken is 9 minutes. We hope to reduce the average time to about 5-10 minutes for routine operations.

PRODUCTIVITY

Productivity in a population is the number of young produced. It is a function of the number of breeding females, the number of litters and the number of young per litter. The present study concerns litter size only. Litter size is here defined as the number of embryonic bulges on the uterus, or the number of uterine scars. The relationship of these criteria to the number of fertilized ova, intra-uterine deaths, or numbers born, reared, or achieving sexual maturity, though important, is not germane to our present objectives. Our data are assumed to be comparable to the data on the embryonic bulges and uterine scars obtained by autopsy.

Results. Of 40 animals operated upon, 12 had no bulges or scars. These were mostly animals taken early in the breeding season and had not yet bred. Later in the season all females had bulges or scars. In the following table the number of females without bulges or scars is shown, for each 4 animals operated, in chronological order.

Date operated	*Number without bulges or scars* (per 4 operated)
Feb. 27–Mar. 1	2
Mar. 1–9	3
Mar. 21–23	1
Mar. 28	3
Mar. 30–Apr. 12	1
Apr. 12–30	1
Apr. 30–May 2	0
May 4–9	1
May 18	0
May 18–June 26	0

Of the 28 squirrels showing evidence of pregnancy, 12 had embryonic bulges averaging 8.25 per female, and 16 had scars averaging 9.8 per female. (Based on 14 observations since the scars could not be counted with certainty in two females). The average for both bulges and scars was 8.6 per female (Table 3).

In 40 females autopsied in 1942 at the Hastings Reservation and showing evidence of pregnancy, Linsdale (1946, p. 337) found an average of 7.5 bulges or scars (Table 3). This is not significantly different from our average (P = .20).

TABLE 3. FREQUENCIES OF FEMALES HAVING DESIGNATED NUMBERS OF UTERINE BULGES OR SCARS.

Number of Bulges or Scars	Number of Females	
	Linsdale	Present Study
5	2	1
6	5	3
7	11	5
8	11	3
9	7	4
10	3	6
11	0	2
12	1	1
13	0	1

SUMMARY

The difficult task of determining the number of young born in an animal population can be facilitated by exploratory surgery to expose the uterus and count the uterine bulges or scars. A surgical technique (ether anesthetic, mid-line incision, mattress-stitch sutures) was used on 40 female California ground squirrels and the effects were compared with 41 unoperated squirrels. Survival was not significantly different in the two groups. It is concluded that the technique is satisfactory and safe to use, although further studies of the effects of nursing and uterine adhesions are pertinent. The mean number of bulges or scars observed was 8.6 per female.

ACKNOWLEDGMENTS

This work was supported in part by Research Grants GM 11329 and GM 11993 of the National Institute of General Medical Sciences, National Institutes of Health, U. S. Public Health Service. Most of the surgery was done by Laboratory Assistant K. Lee Howland. Mrs. Iris S. McRae gave valuable editorial assistance.

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TECHNICAL SESSION

Tuesday Morning—March 9

Chairman: WILLIAM H. MARSHALL
Professor, Department of Entomology, Fisheries, and Wildlife, University of Minnesota, Saint Paul, Minnesota

Discussion Leader: JOHN M. ANDERSON
Biologist, Winous Point Shooting Club, Port Clinton, Ohio

WATERFOWL RESOURCES

WATERFOWL MANAGEMENT IN CANADA

DAVID A. MUNRO
Chief, Canadian Wildlife Service, Ottawa, Canada.

When I undertook the preparation of this paper it occurred to me that it had been some years since a representative of the Canadian Wildlife Service had presented a general account of the waterfowl management situation in Canada to this Conference. It has been longer than I thought. Mair's paper on Canada's contribution to international teamwork in waterfowl management was presented in 1956, and the year before that Gollop and Munro reviewed Canada's place in flyway management.

Before going further, may I take a moment to review the position we found ourselves in nine and ten years ago.

Gollup and Munro said "as current breeding success in Canada goes, so goes the current continental duck crop . . . . Sound management would call for the bulk of habitat improvement efforts to be carried out . . . in the Canadian wheat belt . . . . The United States supporters of Ducks Unlimited have long recognized this point." Writing during a period of relative abundance of ducks, we went on to say that (with respect to the harvestable surplus of) "the principal sport ducks . . . the limiting factor at present is crop damage in the Canadian section of the big Duck Factory during August and September." We said also that our waterfowl management policies must reflect the requirements of farmers, naturalists and businessmen, in fact, the whole community, rather than hunters alone. We thought it desirable to recognize an upper limit to the desirable number of waterfowl, in other words to define an optimum population. Considering the possibility of controlling waterfowl numbers by harvest (those were the good old days), we thought that the effects of varying regulations should be more thoroughly studied.

Since the mid-50's, waterfowl numbers have declined and the extent of waterfowl habitat has diminished. A severe drought was the primary cause of shrinking habitat, but pothole drainage has also contributed significantly, and is, in the long run, more serious. The change in conditions, which we couldn't forecast but did foresee, has caused us to worry less about the need to limit populations, although we don't abandon the premise that it is desirable to establish upper and lower limits of an optimum population range.

The change since the mid-50's has certainly increased our concern about the need to maintain and improve Canadian breeding habitat. As my Minister indicated about one month ago, the Canadian Government is giving active consideration to the problem of maintaining our wetlands. We recognize a need to enter into agreements with landowners for the preservation of some four million acres of pothole habitat in the Prairie Provinces. A ten-year program beginning in 1967, would, on the basis of information presently available, cost about $5.1 million per year. Such a program would not be without complications, as this audience will appreciate, and I am thus not yet in a position to speak of it in more definite terms.

In anticipation of such a program, a pilot study of land easements as a technique to preserve wetlands for waterfowl production was begun in 1963 by the Canadian Wildlife Service. Experience with easements in the United States gained by the Bureau of Sport Fisheries and Wildlife was useful in planning wetlands preservation in Canada, but information relating to Canadian wetlands, landowners and legal systems was needed. During our pilot program, we have surveyed wetlands, drawn up agreements and offered them to landowners; and if they were accepted, we processed them to meet administrative, financial and legal requirements.

The covenants of the agreements were that landowners would not drain, fill, or burn marsh vegetation on wetlands for a period of 20 years, and that they would be paid a sum of money in return. Money was offered as a lump sum to be paid on acceptance of the agreement. The amount of payment was determined from the area of wetlands on the property concerned and the estimated selling price of the land surrounding them (as determined from the assessed value) discounted at five per cent for 20 years. When fully processed, the agreement is registered on the land title to endure with successive owners during the 20-year period.

During the two years the study has been conducted, easement agreements have been accepted in the provinces of Manitoba, Saskatchewan and Alberta. Agreements have been offered to one corporation, one Hutterite Colony and 61 title holders with single or joint ownership. The agreements were rejected by the corporation, accepted by the Hutterite Colony, and by 40 of the individual or joint title holders. Agreements cover 1,806.22 acres of wetlands occurring in 95 quarter sections. The price paid has averaged $14.35 per acre for a total of $25,928.22. Although the average price paid per title holder has been $632.40, about two-thirds of the offers were for less than $500.00. The highest offer was for about $2,500 on a holding of two sections. About one-half the offers of less than $500 were rejected, whereas only one-eighth of the offers more than $500 were rejected. Those rejecting more than $500 reported experience with duck damage, or indicated greater affluence than others in the sample.

The pilot studies will continue through 1966. The information which they yield is providing the basis for planning the extensive waterfowl habitat preservation program mentioned earlier.

A program of wetland habitat maintenance, if it goes forward, might also include acquisition by title of larger wetland areas which may be deemed of crucial importance in supporting migrant waterfowl and waterfowl on the wintering grounds. While we tend to shun ownership of land with all its ensuing complications, acquisition by title seems the only effective way to acquire control over large areas of which a number of landowners each own a part. We are now aware of the location and extent of many of the wetlands important to waterfowl which are likely to be drained or otherwise adversely affected. A few particularly important areas in critical locations will be acquired in 1965 and 1966. On the basis of information at hand, we estimate that a five-year program would call for an annual expenditure of about $400,000.

This program will be carried on in consultation and co-operation with the provincial game agencies. The pattern of acquisition and subsequent management is not likely to be uniform across the country, since we propose to fit our activities into existing provincial arrangements.

Detailed knowledge of our wetland resources is required before specific plans for purchase or habitat maintenance agreements can be drawn up. Knowledge of the distribution and quality of prairie pothole wetlands sufficient for preliminary planning is already available. Analyses of the data on water area occurrence accruing from the annual surveys of the Bureau of Sport Fisheries and Wildlife have been most helpful in this regard, as have the investigations of Lynch, Evans and Conover (1963) and Rose and Morgan (1964). The continuing work of Ducks Unlimited (Canada) on an inventory of the larger prairie wetlands provides additional basic data. In British Columbia and Central and Eastern Canada, the long experience of Canadian Wildlife Service officers enables ready identification of the most significant wetland areas.

Progress toward a more systematic and comprehensive assembly of data on wetlands will be made by two means. The Agricultural Rehabilitation and Development Administration (ARDA) is sponsoring a National Land Inventory, one phase of which will involve the classification and mapping in terms of suitability for waterfowl of all lands within the settled portions of Canada.

The results of the National Land Inventory will be helpful in broad planning of our acquisition program and will also facilitate the second program—a more detailed study of the extent and quality of waterfowl habitat to be carried on by the Canadian Wildlife Service within selected areas in all parts of Canada other than the Prairie Provinces.

In the prairie region the inventory will be made up from data on breeding pairs per square mile and productivity per square mile for individual soil series. Maps for general distribution at 1:250,000 will be prepared. At that scale they will simply indicate that a certain land form is assigned to one of seven rated classes in accordance with its carrying capacity and productivity for waterfowl. The detailed information will be available in our regional offices and some of the details on acreage of potholes of different types will be available in a computer bank.

In British Columbia and Eastern Canada the classification will be geared to wetlands in such a way that it should provide the base for a stratified random sample of waterfowl production.

As I have mentioned, ten years ago we drew attention to the significance of waterfowl damage to farmers' crops in relation to the preservation of prairies wetlands. Four years ago, Stephen (1961) reported on the usefulness of acetylene exploders in controlling duck damage. He found that the exploders were useful mechanisms, but that a more dependable model was required and the need for provision of alternate feeding sites required investigation. Through our efforts a more dependable and sophisticated automatic exploder is now on the market.

The Canadian Wildlife Service has experimented with provision of alternate feeding sites in its programs for controlling damage to grain crops by migratory birds since 1961. It has been learned that ducks were displaced from one commercial grain crop to another as a result of treatment with acetylene exploders or other scaring techniques. The purpose of experimental land management was to provide supplementary feeding space for ducks and sandhill cranes during the early part of the grain harvest period. Experiments were conducted in the vicinities of the north end of Last Mountain Lake, Saskatchewan, and Big Grass Marsh, Manitoba. In both of those areas damage by ducks and sandhill cranes had been a persistent problem to commercial grain growers.

The land management techniques used included securing contracts with farmers to allow migratory birds to feed unmolested in grain crops until a limited amount of feeding had occured. In effect we were buying part of the crop, but only that part which had been made unharvestable by migratory birds. By that technique feeding space was made available in 1963 in 14 quarter sections containing an estimated 750 acres of grain crops in Saskatchewan and Manitoba. Contract payments averaging about $7 per acre were made on crops in six of the quarters. Although the contracts included clauses for the protection of the interests of both the farmer and the public, the apparent usefulness of the technique seemed dependent upon mutual trust and co-operation. Also included in the land management technique was outright purchase of commercial grain crops in the vicinity of Last Mountain Lake, Saskatchewan. Although one good buy, at about $3.50 per acre, was made of a crop that had been damaged by hail, another crop purchased cost about $35 per acre. The utility of the crop purchase technique seems limited.

The other land management technique, used only in Saskatchewan, was grain cultivation on vacant Crown land administered by that Province. The land seeded in those experiments was adjacent to the north end of Last Mountain Lake. Of a total of 540 acres, 60 acres had been previously cultivated as "bird pasture" by the Wildlife Branch of the Saskatchewan Department of Natural Resources; 100 acres had been native grassland; and 380 acres was land already under cultivation acquired by the Saskatchewan Government since 1961. Farming operations on these parcels of land were carried out by local farmers on contract. The cost to the Wildlife Service averaged $8.25 per seeded acre per year.

It was confirmed as a result of other studies concurrent with those experiments that sandhill cranes as well as ducks were displaced from crop to crop by treatments with acetylene exploders. It was concluded from these experiments that with adequate supplementary feeding space, in addition to waste grain available from harvested commercial crops, displacement of ducks and sandhill cranes from one commercial crop to another could be minimized.

We believe we can now demonstrate adequate techniques for the protection of cereal crops from damage by migratory birds. The process of demonstrating and securing farmer acceptance of these techniques will require a considerable effort on our part during the next several years.

A major shortcoming in waterfowl management in Canada has been the lack of national data on the annual harvest. Several provinces obtain information on the waterfowl harvest, but the results are not comparable between provinces and in most cases fiducial limits cannot be calculated. In several other provinces the Canadian Wildlife Service has conducted kill surveys, but these have been based on provincial licensing systems which do not differentiate between waterfowl hunters and hunters of other small game species; so again the accuracy of the surveys is limited.

A proposal for a federal migratory bird hunting license as a basis for a national waterfowl kill survey has received a lot of thought. My Minister has raised the matter publicly on several occasions. A preliminary design for the survey has been prepared. The form of the United States migratory bird hunting license and the surveys associated with it have been carefully considered. We believe that there are about 350,000 waterfowl hunters in Canada now. Imposition of a federal license may diminish that number somewhat, but we expect that about 300,000 licenses will be sold.

Nine years ago Mair (1956) reviewed the jurisdictional situation in Canada, referring to the anomaly whereby migratory birds, being governed by an international treaty, are a federal concern, but are also the property of the Crown in the right of the province in which they may at any time reside. Because of the proprietary interest, it seemed then that most aspects of management were primarily a provincial responsibility. Mair thought that the most useful contribution of the Federal Government, other than through its regulatory activity, would be in the field of research.

What I have reported so far of the current thinking in regard to the Canadian Government's interest in waterfowl management activities is a reflection of our desire to work with the provinces and assume a role more appropriate to the needs in this field. However, it is not intended that there should be any diminution of our effectiveness in the research field.

None of the activities of which I have spoken so far can take place without the adequate support of information obtained by research. The expansion of activities in respect of migratory bird management is to be paralleled by an expansion of research, which we hope by 1970 will be about three-fold in terms of funds and manpower thus assigned.

The Bureau of Sport Fisheries and Wildlife's annual program of waterfowl surveys is, I am sure, the best attempt that has ever been made to define the ever-changing status of a continental wildlife population. We now tend to take its excellence for granted, and to forget that its continuing development is a reflection of the outstanding sense of responsibility which that agency demonstrates in its management of migratory birds. It is, no less significantly, a reflection of exceptional technical competence and managerial ability.

We in Canada have long been embarrassed that our contribution to the surveys that actually take place in Canada has been so insignificant. We expect to be able to make a tangible contribution to the annual assessment of waterfowl populations and the conditions affecting them within the next three years. We are particularly concerned that in so doing we should in no way diminish the quality of the data obtained by the surveys, and so we expect to move slowly in this direction, acquiring skill and competence by working with Bureau personnel before attempting to supplement their activities or provide relief for any portion of them.

Research on migratory birds by the Canadian Wildlife Service will be primarily oriented in support of improving management of the resource, including the expanded activities which have been mentioned, but this does not imply that our research will not contribute to our understanding of the biological characteristics of waterfowl and their ecological relationship.

The Canadian Wildlife Service accepts the outline of needs for waterfowl research and management investigation in the United States and Canada, endorsed by the International Migratory Bird Committee, and is associated with the Bureau of Sport Fisheries and Wildlife in reviewing present research projects and planning new ones to ensure that projects reflect the priority imposed by management requirements. As we go through this process of review it becomes clear that those elements of our research program which are directed toward a precise and detailed understanding of the relationships between various species of waterfowl and their several habitats will have to be emphasized and expanded.

We now have under way studies aimed at determining the food material and food energy requirements of several species of young ducks that use the same habitat during their growing period. Another study is of the nutrient content of foods taken by mallards in spring and this is to be followed by work with captive birds on the efficiency of nutrient utilization by ducks and the possible effects of different foods and nutrients on clutch size and egg viability. We are also investigating the factors affecting the permanency of prairie wetlands and the importance of wetlands in the maintenance of ground water levels. We are attempting to develop rational criteria for the evaluation of wetlands in respect of their capacity to support waterfowl. These studies need to be supplemented by others which will both extend and intensify our effort in this general field.

Another area of research that we consider to be of continuing importance, and which relates specifically to the statement of research needs referred to earlier, consists of studies which throw light on the factors affecting reproductive success and population status. Barry's five-year studies of the reproductive success of snow geese, white-fronted geese and Pacific brant at the Anderson River delta are a case in point. He has demonstrated the broad applicability of weather data in predicting breeding success of those species along the lines laid out by Cooch (1961) in his earlier studies of snow geese in the Eastern Canadian Arctic.

We expect that studies designed to increase our knowledge of population dynamics of the black duck and other species of importance in forested Eastern Canada will receive considerable emphasis in the next few years.

Although the period of major discoveries in regard to the distribution of waterfowl is probably over, interesting and significant information about bird distribution is still being accumulated. During the last several years Dzubin and Sugden have studied and documented an increase in the population of Ross' geese and a pronounced lateral shift in their path of autumn migration. Sugden and others have obtained data on the timing of autumn migrations of Ross' geese and other geese that migrate through Alberta and Saskatchewan. These data have been applied with some success to the regulations governing hunting. All these findings have ecological implications which will be pursued further.

Investigations of waterfowl habitat quality, development and evaluation of techniques for habitat improvement, and preparation of plans for habitat management will be of increasing importance to the Canadian Wildlife Service. We have already undertaken projects of major importance in this field, notably in the Cumberland House area in northeastern Saskatchewan and in the Fraser Delta in southwestern British Columbia. The continued pressure imposed by urban development, proposals for land reclamation, hydro-electric power installations and so forth necessitates a continuing expansion of this sort of applied research.

We have established the nuclei of research groups studying diseases and parasites of wildlife and the effects of pesticides on wildlife. The former group has had to give prior attention to problems involving large mammals, but we propose eventually a thorough survey of the incidence and significance of diseases and parasitic infections among migratory birds in Canada. In the pesticide field we are particularly concerned about the possible effects of several years' use of dieldrin for grasshopper control in the Prairie Provinces. Use of dieldrin has been largely discontinued, but the possible consequences of the passage of residues through the food chain to both young and adult waterfowl require definition. Relevant investigations have begun and will be expanded this year.

For the past several years we have attempted to step up our efforts to let the public know some of the facts relevant to waterfowl management. We have produced and distributed, in two languages, about 330,000 copies of a brochure entitled "Waterfowl—A Resource in Danger," and about 200,000 copies of a cartoon booklet called "The Swamper." The specific objective of both publications is to pave the way for the extensive program of prairie pothole maintenance through agreements with landowners. A film with essentially the same story line is being produced for us by the National Film Board and should be released this month.

The total increase in wildlife management and research for which the Canadian Wildlife Service will be responsible presents problems of management, organization and staffing. In anticipation, we began a decentralization of the day-to-day operations of the Service in 1962. We now operate with a two-regional system, and we believe that with minor modifications it will adequately serve the program I have outlined.

We expect difficulty in recruiting qualified staff in the numbers that will be required. In an attempt to ease that problem we inaugurated in 1964 a modest scholarship scheme for graduate students of biology in Canadian universities. Scholarships presently are awarded in units of $1,200 and are based on academic achievement, relevancy of research to wildlife management problems, and personal suitability of the applicants. After another year or two of experience with the system and depending upon the availability of funds and assignment of priorities, we plan to offer between 15 and 20 scholarships each year.

In order further to stimulate interest in wildlife biology, the Canadian Government proposes to extend additional aid to universities by entering into contracts for the accomplishment of research of mutual interest. We are now spending the modest sum of $10,000 per year for that purpose. If this proves to be a useful extension of our activities we may allocate as much as $50,000 per year to it.

We hope that the program that has been outlined here will enable us to catch up with the events that have so profoundly affected waterfowl during the past two decades. We foresee no let-up in the pressures of expanding human populations, increasing incomes and amounts of leisure time, and competing land uses. There seems little doubt that what we envisage for the immediate future will be only the first stage of a continuing struggle to maintain a valuable resource at a level useful to man.

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DISCUSSION

VICE CHAIRMAN ANDERSON: Thank you very much, Dr. Munro. Dave has given us a good look at what has happened in Canada in the last half dozen years, a glimpse of his future plans and it is very gratifying to see that Canada has such a vigorous research program in the field of waterfowl already underway.

MR. B. J. ROSE [National Wildlife Federation]: I am not trying to put you on the spot, but do you feel that the average price that you would pay on these trial areas has set a precedent in Canada?

DR. MUNRO: Well, the price we pay is based on the assessed value of the land and, as you know, assessments of lands in those areas are quite realistically calculated. But I would suggest that as our program moves into areas where the lands are perhaps less desirable for agriculture then there will not be too many of these areas because those we have already worked are by no means the better farming lands. They are about average. Therefore, we may be paying some higher prices but, in the long run, I think the precedent is that a fair price was paid.

MR. ROSE: I agree that the price was probably fair, but we conducted a land ownership survey up there, interviewed a few landowners, and we are in the process of interviewing 150 in Saskatchewan to obtain an estimate for this type of program. Our question to them was whether or not they would accept an easement on their land for 20 years at $7.00 per acre. This was not adjusted for differences in value of the habitat but would be the average price for 20 years for this type of easement. However, the thing that is bothering us on a 20-year easement program is that in the next 20 years they are going to want more money. I don't think there is any doubt about it and, further, this average price was more than what some of the acquisition people have paid for easements for perpetuity here in the United States. I merely wanted to make this point.

DR. MUNRO: Well, I have no doubt that they will expect more when the 20-year period is up in connection with renewal. However, I would say that they deserve more because, after all, land values will also have risen by that time.

Our intention is not to endeavor to drive the hardest bargain we can. I know there have been some places where easements have been obtained for nothing and where permanent easements have been obtained for below the going price. However, part of the philosophy behind this program in Canada is that it is desirable to inject into the agricultural community a flow of cash, which will not only serve to secure more waterfowl habitat, but also stimulate the landowners to identify themselves with the program. In other words, we are seeking to indicate that an income from the land for the purpose of waterfowl production is comparable to an income for any other use. So we are not interested in getting free easements and easements in perpetuity. We are seeking to develop this continuous flow of cash which relates to the land and the value of waterfowl produced on it as best we can manage.

MR. ROSE: Of course, I would like to agree with that because in our survey up there, it was indicated that any monies they received from these wetlands would be above and beyond anything they have ever received from them in the past and, further, depredation might be curtailed at the same time with these easement payments.

DR. MUNRO: Of course, we hope so.

WATERFOWL RESEARCH—ACCOMPLISHMENTS, NEEDS, OBJECTIVES

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Through the years since man became curious of his surroundings he has discovered a great deal about the wild ducks, geese and swans that share his environment. The sum of this knowledge now in print is impressive. Indeed, except for the domestic fowl, there is no group of birds more completely discussed in literature than waterfowl.

Patient explorations year by year have located the breeding ranges of waterfowl; and after World War II our knowledge of the spread of ducks in spring and summer became thoroughly refined. These postwar studis exploded some myths about the sources of waterfowl, and we were brought to realize that the proverbial "north," from which came the annual flow of ducks, was the farmland of prairie states and provinces.

In the 1930's, studies of breeding behavior revealed how nesting pairs became isolated by sexual strife. This understanding created a new outlook for management. It became clear that many square miles were required to produce a flock of ducks; that a wilderness marsh could hold no higher densities of pairs than slough and pothole country in rich agricultural land.

The paired distribution of ducks induced research in census techniques; birds were much easier to count in small groups than in flocks. The surveys of the past 19 years have shown where each kind thrives. We know nearly as much about the density of prairie waterfowl as we do of domestic stock. Moreover, there is a clear record of their ups and downs as drouth, drainage and other changes in habitat caused shifts and declines in population. Studies of waterfowl on their wintering grounds have rounded out the picture; we know where most of the North American ducks live the year around.

On the basis of mass bandings, reinforced by intensive studies of visible migration and tracking with radar, we know when waterfowl migrate, their routes and destinations. Main passages can be predicted through an analysis of weather data. Such knowledge has become of increasing importance as we learn that ducks cannot be managed as though they were all Mallards; that, species by species, there are important differences in timing, in resting places and in destinations, so that as pressures of civilization increase, the need for special attention for some kinds becomes ever more important.

The significance of hunting as a mortality factor and the influence of individual regulations on the total kill have received increased attention. In this work, great masses of data derived from banding programs and hunter-harvest studies have been analyzed by the biostatistician, a relative newcomer to the waterfowl research field.

All waterfowl adapt well to captivity, hence their sex and age characteristics, their breeding behavior and their reproductive potentials are understood far better than in most families of birds. Perhaps there is a lesson to be read in the fact that some of the techniques for captive breeding, especially of rare North American species, as the Trumpeter Swan, or declining birds, as the Canvasback, are more highly developed in Europe.

We have enlarged our knowledge of waterfowl ecology. Environmental situations available to ducks and geese for breeding, migration and wintering have been examined to explain degrees of use and non-use. We understand much more of the needs and tolerances of waterfowl for food, cover, water and security. Prescribed burning, regulated grazing, supplemental feeding, controlled water levels, artificial nesting sites, and strategic placement of refuges are but a few of the tools now employed on intensively managed areas. Drastic changes in habitat caused by moisture cycles, hurricanes and human activities during the past 20 years have afforded opportunities to study the effects of major alterations in environment on waterfowl. We now are better able to anticipate and explain natural ups and downs in waterfowl numbers, shifts in distribution and changes in behavior.

This has not been an exhaustive review of accomplishments in waterfowl research; our purpose has been simply to show that knowledge of waterfowl has reached an advanced state. But it is commonly agreed that fact finding has not kept pace with needs.

Research calls for curious men with the time and the means to examine their surroundings. In waterfowl biology, the needs of research never before have been met so bountifully. Where one man gave full time to research before the war, 20 or 30 biologists now devote their energies to waterfowl studies. Where there were only hundreds of dollars, we now have many thousands.

What needs should be met by this expanding effort? We claim no monopoly on ideas. In preparing this paper we have referred to several of the processed briefs outlining research needs that have been turned out during the past three years by committees of United States and Canadian biologists (Mississippi Flywoy Council, 1962; U. S. Fish and Wildlife Service, 1964; U. S. Fish and Wildlife Service and Canadian Wildlife Service, 1962). Our concern in this discussion is not a close look at needs per se but rather an examination of the current state of waterfowl research, for here, we believe, are to be found clues to its productive future.

Clearly there is a requirement for improved communication between research an dmanagement. Research biologists must do a better job of making the results of their studies available for others. Publication not only accomplishes this end; it also gives evidence and discoveries the benefit of scrutiny by men of varied experiences and outlooks the world over. And when a scientist is obliged to place his results in the open where they may be examined by his colleagues, he adjusts to a disciplined analysis of his work that comes about in no other way; he learns the truth of his findings through this ordeal. By not publishing the meat of his data, the research biologist is doing little more than whispering in his own beard.

There is a fundamental need not only for publication of current research, but for consolidation of the mass of raw data already in hand. For example, many of the findings gathered by cooperating agencies in the waterfowl breeding ground surveys of the past 19 years are difficult to use in their present form. Some *Special Scientific Reports* holding this material are out of print and are not widely available in libraries. These records should be condensed, analyzed and published while workers who gathered the material are still active. How can we plan for tomorrow without a clear view of where we are today?

Back in the 1930's, the need for presenting the results of research before the lay public was frequently stated. Here is one field where great advances have been made during the past 20 years. Many of the states are keeping their public informed through popular fish and game magazines and semi-technical bulletins. The caliber of writing is often excellent and the results of research reported in clear, simple language. The Fish and Wildlife Service and the Canadian Wildlife Service have produced several popular bulletins on their activities, and now we have *Waterfowl Tomorrow,* (Linduska *et al.,* 1964). a grand compendium of information on many phases of waterfowl management and research.

There is need for socio-economic studies of our waterfowl resources. "Under democratic systems the ultimate judgments of what is good and what is bad about the utilization of resources and the goals thereof are products of public opinion" (Kelson, 1955). Studies are needed relating waterfowl and their marshes to the society of man, this requirement intensified by the differences in public opinion on waterfowl conservation that now exist between Canada and the United States. Surely the overall plan for waterfowl research should make use of disciplines other than biology to sort out the forces at play and to provide the necessary social and economic foundations for the preservation of waterfowl resources.

Data on breeding-ground densities in the United States indicate that less than two per cent of game ducks nest on refuges and other public lands (Crissey *et al.,* 1951; Williams *et al.,* 1950). Similar conditions prevail on the Prairie Provinces. Socio-economic studies may point to ways and means for creating new incentives for the preservation of breeding habitat on private farmland.

In this same field there is need for a continuing program of research in the relation of the hunter to his game. Through the long steady decline of the hunter's privileges, the general idea seems to have been that some good must result simply by tightening the screw. Now we have a mass of laws that restrict freedom but possibly without commensurate savings of birds. Good laws effectively enforced are waterfowl management's oldest and most useful tools. Law, it has been said, is the "science of liberty" (Beudant, 1891). Surely it must be possible, through research, to conserve our waterfowl under sound, enforceable laws which at the same time take into account the dignity of human freedom.

There is need for more intensive studies of the potential of local waterfowl habitat. Minnesota, Wisconsin and New York State are examples of jurisdictions that have pioneered here. An awareness of the productive capabilities of native wetlands must come about if wildfowling is to survive. In the United States, there has developed the habit of looking ever north for the bulk of our supplies; and this has held in Canada as well. But there is evidence that the combined home product of each state and prairie province makes up most of the entire flight. Knowledge of local waterfowl will incite concern for local populations, a step toward more efficient management of the resource as a whole.

There is a need to study the bird itself. Waterfowl research since the war has developed as a science of counting, but we simply do not know enough about the birds we tally. To balance expenditure of hundreds of thousands of dollars for survey, there is not enough spent on studies of the bird—good old-fashioned life-history studies benefiting by new techniques in hand. There remain many mysteries about the common Mallard, for instance, that must have bearing on its welfare and management. And the Mallard is but one of 30 species of ducks on our shooting regulations today. Direct study of the bird itself should be encouraged at all levels—in graduate school, by university faculty, by state, provincial and federal offices.

There appears to be a need for better rapport between waterfowl biologists and colleagues in closely related disciplines. Most noticeable is the gap between waterfowl men and ornithologists studying other birds, but there is also a failure to become familiar with many other closely related sciences. Such voluntary isolation separates our field from newly discovered truths close to our problems. We are becoming detached from sources of information vital to the welfare of the resources we hope to manage.

There is a need to revitalize the study of waterfowl diseases. This will come about, doubtlessly, as total supplies dwindle and the impact of non-hunting mortality is more fully realized. But we must not let the priorities of habitat preservation and species management dull our concern for disease. Botulism almost every summer claims a shocking number of birds. It would not surprise us to learn, if all the facts were available for analysis, that botulism losses for some recent years in Manitoba approached 50 per cent of the legal harvest. Yet a complacent or defeatist attitude seems to have developed toward botulism, and this just at the time when Bell, *et al.* (1955) have produced the tenable microenvironment concept, when Cooch (1964) has shown a possible involvement of the salt gland, and when pharmacology has made important strides with antibiotics. Botulism research, we believe, is at the threshold of its most important discoveries, but new stimulus is needed.

There is a renewed interest in lead poisoning, but fowl cholera remains an enigma commanding little attention. Algal poisoning is still a mystery, but basic research is being carried forward by plant physiologists and public health scientists far removed from the waterfowl field. There is evidence that some diseases are increasing due to impact of man's ever-growing role in the ecology of waterfowl habitat. If the actions of man increase the incidence of diseases, there must be some steps he can take to reduce or control these outbreaks.

There is a need for every organization that is carrying out waterfowl research to evaluate the effectiveness of its research program. Aldo Leopold (1948), before this same Conference 17 years ago, said, "Fumbling during the first decade of wildlife research may be explained—and dismissed—as growing pains." He admitted, "All of us fumbled, more or less, in the early days." Then he added, "None of these alibis for fumbling exist today. To reduce fumbling is our most important job." The waterfowl research effort of 1965 is much more impressive in terms of size than that of 1948, but is it relatively more proficient?

To answer this question will require each sponsoring agency to compare its research program with the accepted standards for sound research administration. Useful guiding principles, recently laid down by Dr. L. J. Lyon (1963), emphasize that successful research requires competent personnel working in an inspired atmosphere under a skilled research director within a framework that produces a continual flow of ideas from the individual scientist to senior management.

What is the best starting point for improving a research organization? The basic ingredients of good research can be listed, and treating one or another of them separately will occasionally help. But we believe that the key to the solution is at the top—that by insisting on sound principles of scientific procedure, administration will build a stronger, more efficient and useful research organization while at the same time attracting well-trained young men disciplined in the traditions of science.

OBJECTIVES

There is considerable misunderstanding regarding the relation between scientific research and the need for practical information by management. Science does not scorn the practical. Indeed, research thrives only where its products contribute usefully to human development. But we must resist shortcutting in the name of practicability. This tends to lead research down narrow trails while at the same time well-trained scientists are induced to find employment in other fields.

Practical goals themselves are not out of order. Columbus' journey across uncharted seas is an outstanding example of basic research. His objective was India and he had practical reasons for seeking this goal. But research, like Columbus' discovery of America, which could not possibly have been planned in the beginning, is most effective when it may advance in an atmosphere of academic freedom allowing the scientist to examine side trails and accidental encounters met along the way. And yet today, all too often, we are told, in effect, "Our objective is India; let no islands deter you from reaching this goal."

It is inevitable in war, sometimes reasonable in peace, to design crash programs of research directed toward an achievable goal already in sight. In the long run of years, however, history tells us that the greatest benefits research can bestow upon mankind must come from fundamental, long-term studies carried out in an atmosphere of academic freedom. In these 1960's there seem to be urgencies demanding direct and speedy solutions through research. Let us hope, for the good of man and bird, that this feeling of urgency does not infect the entire community of biologists, that one and all are not driven to search in the same direction nor obliged to strike unerringly toward established goals.

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DISCUSSION

DISSCUSSION LEADER ANDERSON: Dr. Hochbaum, would you care to comment on whether research results are being put to full use today?

DR. HOCHBAUM: In defense of research we must point out there is a vast back-log of facts published over the past 25 or 30 years being used little or not at all. In waterfowl depredations, for instance, several investigations have produced recommendations that if applied might abate farmer-waterfowl conflicts. And yet administrators meeting this problem often direct their response to farmers with little reference to these studies.

There are enough life history, range, and migration data to effectively protect Canvasback and Redhead in years when their numbers are low while other waterfowl exist in shootable populations. But these data play little or no part in regulating and controlling the harvest of these species.

Still again, to cite another of many examples, population studies of the past 19 years leave no doubt that most game ducks breed on private land; the salvation of their breeding ranges depends upon private interest. In spite of a huge amount of literature decrying the loss of potholes by drainage, little has been done to encourage private marsh preservation and management,

Although there is much we do know about botulism, research has shown that it may be held in check by astute control of water level and by frightening birds from "hot spots." Literally hundreds of thousands of ducks might have been saved during the last decade if more attention, funds and effort had been directed to botulism control.

There are good reasons why the facts produced by research are not employed by management. One of the most conspicuous is the failure of the many governments involved to firmly agree on individual and collective responsibilities. Another major reason is our present way of life; research points to procedures that simply do not fit into the social and economic climate of our time. Under the pattern and structure of contemporary waterfowl management, for instance, it is not considered wise or expedient to use many of the facts that reseach has produced for control of waterfowl depredations on farmland. The same holds for species management of Canvasbacks and Redheads. Incentives to landowners for private marsh management are not popular at this stage of history.

Perhaps one of the greatest needs of our day is the realization that research does not provide magic answers to any dilemma. It requires courage and great understanding for an administrative office to test and apply the medicine research prescribes.

WATERFOWL SPECIES MANAGEMENT: PROBLEMS AND PROGRESS

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INTRODUCTION

Recently, waterfowl biologists and administrators have shown increasing interest in managing waterfowl by individual species. Two major factors seem to be responsible. The first is certainly the restrictive regulations of recent years resulting from drought in important breedings areas. This has caused a search for species or populations units either not affected by the drought or not adequately harvested. The purpose, of course, is to use these species to supply recreation during periods when other birds are in short supply.

The second factor is a growing fund of knowledge concerning population dynamics which demonstrates the need for management by individual species if the waterfowl resource is to supply maximum harvest over a long period of time. These data have shown that some species of waterfowl differ in their characteristics as much as do pheasants and grouse and that management techniques suitable for one species may be unsuitable for another. On occasion, the data have suggested that some species or population segment should be able to sustain additional harvest. At other times the data have demonstrated the need for more protection. It is the purpose of this paper to summarize existing knowledge concerning species management and to use this as a basis for judging the future of this type of management.

METHODS

One of the major tools for managing waterfowl by species is shooting regulations. This tool has been used for many years in the form of restrictive or closed seasons for a particular species. It was first employed in Louisiana in 1904 when the season was closed on wood duck. Since that date either closure of season or limitations on length or bag limits have been applied to a variety of species. A recent example was the closure on the redhead and canvasback from 1960 through 1963. Restrictions or closures for a given species also have been employed on a time and area basis. The need for protecting various segments of the Great Basin Canada goose population has prompted reduced bag limits, closures, and adjustments of either opening or closing dates in selected areas. Recent regulations delaying the opening of the season on white geese until October 5 in a portion of Saskatchewan constitute another example. By this date, the bulk of the Ross' geese have migrated southward and even though they can now be legally taken, the kill of this species has been materially reduced as compared to kill during seasons which opened in September with a complete closure on Ross'.

Another variation of the use of delayed opening as a species management tool occurred several years ago in Florida (Sincock, 1957). At the time, State personnel were concerned about the status of the local Florida duck population. They ascertained that, with an early opening, shooting pressure was directed mainly on their local birds because the migrants had not yet arrived. Delaying the opening until late November allowed large numbers of northern birds to move in and materially reduced the pressure on the Florida duck.

Not all shooting regulations for managing species have been restrictive. Larger bag limits, longer seasons, or more shooting hours have been established for a variety of reasons and in a number of locations. An overabundance of birds has prompted progressively more liberal shooting regulations for mallards in the Pacific Northwest in recent years. To control depredation on rice in the Pacific Flyway, bonus bags were established on pintail and baldpate from 1952 through 1958. Longer seasons and larger bag limits also have been established for species that either are not particularly vulnerable to shooting or are not highly prized by hunters. Scoters and mergansers are good examples of this. Over the past several years, scaup bonuses have been established in various ways to increase harvest rates on this lightly shot species. These bonus regulations have been made to include entire flyways or specific areas within flyways. In the eastern Canadian Provinces, extra scaup in the bag have been allowed during the latter part of the season after less numerous species, including the canvasback and redhead, have migrated southward.

Split seasons have been used to increase harvest rates for an individual species. The selection of seasons last fall by Iowa is a recent example. The State elected to open the season for 2 days on October 3 and 4 to take advantage of the early flight of blue-winged teal and then opened it again on October 24.

PRESENT STATUS OF KNOWLEDGE CONCERNING SPECIES MANAGEMENT

There is much that we know, a little that we suspect, and much that we don't know about managing waterfowl by species. Prior to about 1954, there was little possibility of evaluating the various shooting regulations established to either protect or exploit individual species. During the past 10 years, a data-gathering program of sufficient magnitude has been operating in North America to measure the results of at least a portion of the species management efforts. From the evaluations a degree of understanding has developed. Also, it is now possible to pinpoint gaps in our knowledge and to suggest methods for securing the information.

Restrictive Shooting Regulations:

Although there are still many questions concerning the relationship between shooting regulations and population survival, evidence is accumulating that for many species of migratory game there is a direct relationship between hunting regulations and shooting pressure and, in turn, between shooting pressure and survival. Geis (1963) gave a paper at the North American Wildlife Conference in which he presented data and discussed the problem. Since then, a rather thorough analysis of black duck banding and population data have been completed and banding data for several other species have been reviewed in a preliminary way. In varying degrees these analyses support the contention that restrictive shooting regulations increase survival and refute the generally accepted principle developed for resident game that *"if you don't shoot them they will die anyway."*

If waterfowl losses due to natural causes were density dependent, then the fraction lost due to factors other than shooting should have been higher when populations were larger, and lower when they were smaller. Actually, when mallard breeding populations exceeded 10 million birds during the midfifties (Crissey, 1964), the annual loss rate due to natural causes varied between 10 and 20 percent of the population present on September 1. During recent years, with populations about half the midfifties level, loss due to factors other than shooting has remained within the same 10 to 20 percent level. In other words, *so long as we are dealing with populations no larger than those of the past decade,* a comparatively small and rather consistent portion of the population has been lost due to natural causes during periods when the population level fluctuated widely.

On the other hand, banding data demonstrate that restrictive shooting regulations have markedly reduced the fraction of the population present that is killed within a given season. During the midfifties, with bag limits of four or more and season lengths of 70 to 95 days, first season recovery rates on mallards were much higher than they were with the much more restrictive regulations in 1962 and 1963. For example, winter bandings of mallards in Colorado in 1956 and 1958 had first season recovery rates five times greater than in 1962 when the bag limit was one mallard and only 25 days of shooting were allowed (Grieb, Ballou and Geis, 1964).

Of greater significance are analyses of accumulated data which demonstrate a positive relationship between band recovery rate and mortality. For example, an analysis of black duck banding data just completed (Smith and Geis, 1965) shows that populations with 15 percent recovery rates had annual mortality averaging 71 percent with 44 percent of the annual loss being due to hunting mortality and 27 percent to other causes. In contrast, populations with 5 percent recovery rates had a total mortality rate of 49 percent with 13 percent due to hunting and 36 percent due to other causes. Thus, both total and hunting mortality were affected greatly by changes in shooting pressure, while mortality due to natural causes varied only 9 percentage points.

Perhaps a way to illustrate some of the principles is to ask ourselves the question: What would happen to the mallard population if we did not hunt for a period of years? Sufficient clues from data collected in the past at least permit reasonable suppositions as to what might happen. First, the data demonstrate that at population levels of recent years, and measured from the time the birds are old enought to fly, losses due to causes other than shooting have averaged less than 20 percent annually. Second, since the early fifties, the production ratio in the mallard population has ranged from a peak of about 2 young per adult to a low of 0.5 young per adult. This variation in production was caused by fluctuating pothole breeding habitat which, in turn, resulted from variations in rainfall. If hunting were to cease for several years, it seems likely that at first production would exceed mortality and the population would increase rapidly, particularly if pothole habitat was well watered at the time. As the population increases, it seems logical that the more crowded conditions along the migration routes and on the wintering grounds might increase the mortality rate. However, the small changes in rates of loss due to causes other than shooting that have been associated with rather large changes in the size of the breeding population in recent years make it hard to believe that the loss rate would increase very much. On the other hand, the wide range in production ratios that have been experienced and their obvious relation to amount of breeding habitat suggests that the mallard population would rapidly expand to the extent of its breeding habitat. As the population continued to increase, greater and greater proportions of the population would be unable to find suitable breeding areas. Accordingly, we would forecast that after a relatively few years, the mallard population would increase from two to four times its present size. At this level, it would exceed the capacity of its breeding range to the extent that the average production ratio would be about 0.25 young per adult. This ratio would approximately balance the mortality rate, and the population would become stable.

For a few other species, we know that rate of loss due to natural causes exceeds that of mallards. For example, the annual loss of black ducks due to causes other than shooting averages about 30 percent during their first year and about 18 percent thereafter (op. cit.). For blue-winged teal it is even higher. At present, we do not know whether a lower population of either black duck or blue-winged teal would result in a lesser mortality from natural causes. However, black duck populations have fluctuated considerably during recent years. An analysis of the banding data suggests that the *proportion* of these birds lost to natural causes during periods of high populations has been no different than that when the population was lower. This leads to the conclusion that natural mortality among black ducks is not density dependent at population levels experienced in recent years. That is, a more or less constant fraction of the population dies due to natural causes regardless of population size. This single factor causes restrictive regulations to be potent management tools, because kill is largely additive to other mortality, and a large proportion of birds that are not killed will survive.

Liberal Shooting Regulations:

What about the value of more liberal shooting regulations as species management tools? In this general area we run out of answers rather quickly, primarily because we lack knowledge concerning factors currently limiting the populations of lightly harvested species.

For example, if we increase the harvest of blue-winged teal and the population is not reduced, one or both of two things must happen. Either a decreased natural mortality rate must compensate for the additional harvest, or a decrease in breeding population will result in a higher rate of production then would otherwise occur. Actually, we have little information bearing on either situation. It is at least possible that the rate at which blue-winged teal are lost due to natural causes during the migration and wintering periods is independent of density. Blue-winged teal, which winter mostly in Colombia and Venezuela, make the longest fall and spring migration of any North American waterfowl. It is conceivable that loss during this long migration is a more or less constant percent of the number of birds making the flight. If this should prove to be true, then additional harvest will simply add to the total mortality. This hypothesis is substantiated to some extent by breeding population aerial survey indices from 1959 to 1962. Due to drought in key breeding areas, the index decreased 48 percent in 3 years. However, if a lesser density of blue wings had been associated with higher survival, then the population should not have decreased as sharply as it did.

In blue-winged teal breeding areas, it is possible that lower populations have reproduced at a higher rate than would have been the case had the breeding population density been greater. However, if this has been so, it has been completely obscured by very large fluctuations in the amount of habitat available to the birds. The blue-winged teal is a prairie pothole nester and, because of drought conditions, the amount of this habitat has varied during the past decade from more than 5 million potholes in July of 1956 to less than one-half million in July of 1962. It is obvious that during the drought period, at least, there have been many more blue-winged teal in the breeding population than could find suitable places to nest. This has been demonstrated by sharp reductions in the ratio of young to adult birds in kill by hunters as measured by the Duck Wing Collection Survey.

The important point is that we do not know what will happen if the harvest rate of blue-winged teal is increased, and there is no means of evaluating past data to determine the answer. The only way to find out is to experiment. On January 15, the Department of the Interior announced that a special 9-day teal season would be allowed in the fall of 1965 in Central and Mississippi Flyway States between the dates of September 1 and 30. Provisions which have been made for evaluating the results include measurement of the effect of additional kill on blue-winged teal populations as well as determination of the ability of hunters to refrain from shooting species other than teal during the special season.

Information presently available suggests that waterfowl species may be quite unequal in their ability to withstand kill by hunters. Of major importance are variations in average production ratios. To illustrate the principle by exaggerating the example, it is quite obvious that mallards which breed when 11 months old and lay 10 eggs are potentially capable of withstanding a higher portion of their fall population being harvested than are swans which do not breed until they are 3 years or older and lay only 4 - 5 eggs. These differences in production potential are balanced by corresponding differences in rates of loss. Within these variations of production and mortality, and depending on the causative factors, some species can withstand high harvest rates without decrease while others cannot.

I hasten to add that present regulations probably do not provide for the greatest possible harvest of each waterfowl species on a sustained yield basis. A combination of banding, population, kill survey, and age ratio data suggests that certain species or population segments may be able to supply additional harvest. Lesser scaup may be an example. Quite recently, a rather startling bit of information has turned up which suggests that production ratio for lesser scaup may be very low. Specifically, age ratios in the kill as determined by the wing collection survey have been about average in comparison to other species during the past 3 years. However, based on bandings of young birds and adults in Alaska during the same period, it appears that a much higher proportion of the young birds are shot than adults. When this differential in vulnerability to shooting is applied to the age ratios observed in birds killed, the corrected age ratio in the scaup population during the last 3 years has been very low indeed, perhaps no more than 0.3 to 0.4 immatures per adult as an average. Since there is no evidence that the scaup population decreased during this period of low production, mortality must have been correspondingly low.

The lesser scaup is primarily a northern nester. Northern habitat is not plagued by long periods of drought, as is prairie pothole habitat, and the quantity available each year is more or less constant. Although northern habitat seems to be present in vast quantities, the truly productive portion of northern habitat, mainly river deltas and river flats that are periodically flooded by silt-laden water, are surprisingly restricted in area. It may be that these habitats are overstocked with scaup. This is one situation in which a reduction in density of breeding population may result in a higher rate of production. Attempts have been made to increase scaup harvest by means of bonus bag regulations, but so far they have not been particularly effective. If it does prove feasible to increase scaup harvest rates, and if the size of the breeding population is decreased as a result, it should be possible without present data collecting programs to determine if this reduction in breeding population is compensated for by an increase in average production ratio. I wish to emphasize "average" when speaking of a production ratio associated with a species that breeds primarily in the North, because weather conditions are such that wide fluctuations in breeding success occur from year to year. The major difference between prairie and northern breeding habitat seems to be that northern habitat is not subject to sweeping trends in conditions with several years of abundant habitat being followed by several years with reduced amounts of poor quality habitat. Rather, a "bust" year due to severe weather conditions can be followed the next year by favorable conditions and peak production. For these reasons, it is concluded that the problem of managing northern breeding species may be fundamentally different than managing species that breed primarily in prairie areas subject to wet and dry cycles. As with blue-winged teal, the only way to find out what will happen if scaup harvest rates are increased is to experiment.

Mallards—Pacific Northwest:

No discussion of species management would be complete without mentioning the mallard situation in the Pacific Northwest. In the Columbia Basin in Washington, Oregon, and Idaho, and primarily due to development of large irrigation projects, a situation attractive to mallards has developed in recent years. The habitat is a combination of reservoirs and harvested grain fields. The birds develop habits of resting on the reservoirs during the day and feeding in the fields at night. As a result, they have a low vulnerability to shooting.

Also, the quality of the habitat is such that loss due to causes other than shooting is low, particularly during mild winters such as have existed during recent years. With low rates of loss, the Columbia Basin mallard population has increased in recent years in spite of below average production ratios due to drought in important breeding areas. According to the annual winter survey, the population increased from an average of about 400,000 prior to 1956, to about 1 3/4 million in the last 4 years. This increase was recognized by establishing bonus bag limits beginning in 1961. Since then, the shooting regulations for mallards in the Columbia Basin have been further liberalized with the 1964 regulations allowing a daily bag of 8 with a possession limit of 16 (of which 4 and 8, respectively, must be mallards); extension of the season to a maximum length of 107 days; and an extension of shooting hours to 1/2 hour after sunset. So far, these liberalizations have failed to increase the harvest rate materially. It may be that a considerable departure from standard hunting methods will be required if this is to be accomplished.

You may ask why is it necessary to increase the harvest rate on this population of birds. The answer has several ramifications. First, it seems likely that as long as production exceeds mortality the population will continue to increase. Even at the level which exists today, waterfowl administrators in the State of Washington have warned that serious winter losses can be expected if a severe winter is experienced. If we accept the fact that the present size of the population is adequate, then the problem is one of increasing mortality rates so as to bring them into balance with production. For many reasons, it seems advisable to increase mortality by means of additional harvest rather than to allow occasionally severe winter weather to accomplish this loss.

Also, there is a suggestion in the banding data that the large wintering population of mallards in the Columbia Basin, which now comprises nearly one-fifth of the continental total, is related to the number of birds available to hunters in the Central and Mississippi Flyways. A preliminary analysis of the data suggests three things. First, once a bird has selected its migration route and wintering area, there will be few changes during the remainder of its life. We conclude, therefore, that there has been no shift to the Pacific Flyway of birds that have migrated once or more to either the Central or Mississippi Flyways. Second, recoveries of birds banded in the Columbia Basin during the winter suggest that southern Alberta is a primary breeding area. Third, banding of young mallards in southern Alberta, both before and after the build-up in the Columbia Basin occurred, suggests that a slightly higher portion of young from southern Alberta are now being harvested in the Central and Mississippi Flyways than before the build-up. This may seem contrary to expectations. However, you must remember that a band recovered represents a bird killed and does not necessarily represent comparative distribution of birds to the place of harvest. In the Columbia Basin, there has been a very large increase in number of birds present with only a small increase in the number killed. Therefore, the kill during the last few years has represented a smaller fraction of the birds present than before the build-up in population occurred, and this is true for banded birds as well as unbanded. In contrast, harvest rates of mallards going to the Central and Mississippi Flyways have remained comparatively high. Therefore, even though the distribution of young birds from southern Alberta to the three flyways may not have changed, the distribution of band recoveries shows a somewhat lesser portion now being taken in the Pacific Flyway due to a decrease in the proportion harvested.

Although the distribution of young mallards from the primary breeding areas may have remained the same, there is reason to believe that the distribution of adults may be different. The reasons are these: First, the Mississippi and Central Flyways and the Columbia Basin have many breeding areas in common. Second, during the period when the mallard wintering population in the Columbia Basin was increasing, the populations in the Mississippi and Central Flyways were decreasing. Since these changes cannot be accounted for by differences in rates of production associated with the three areas, then the rate of survival must have been higher for the Columbia Basin birds than for those in the two Flyways. Third, when several wintering areas are associated with a given breeding area, like southern Alberta, and when one of the wintering areas, such as the Columbia Basin, enjoys a higher survival rate than the others, then adult birds with a tradition of returning to the wintering area with higher survival will gradually increase. Thus, it seems likely that a higher portion of the adults in several of the major breeding areas supplying the Mississippi and Central Flyways are now oriented to the Columbia Basin than before the build-up occurred. Since an average fall flight is made up of nearly as many adults as young in an average year, present flights of adults to the Mississippi Flyways. The degree to which fewer adults in the fall flights would be if the Columbia Basin concentration did not exist. On the other hand, mallards in the Columbia Basin seem to constitute a reservoir of breeders which supply young to the Central and Mississippi Flyways. The degree to which less adults in the fall flights to the two Flyways is compensated for by more young is not known.

Duck Production—Dakotas and Western Minnesota:

In contrast to the situation in the Columbia Basin where for mallards the average production ratio in recent years has exceeded mortality, there is a strong suggestion that the reverse has been true in the Dakotas and western Minnesota. In this instance, a breeding population is involved and the implications are more serious.

Hochbaum (1947) presented a paper at the North American Wildlife Conference in which he proposed that duck production in important breeding areas was being reduced by "burning out" the breeding population with overshooting. Recent data substantiate his earlier findings and since species are effected differently by the factors involved, the problem is worthy of discussion in this paper.

First, during the past 10 years the most numerous breeding duck in the southern portions of the Prairie Provinces has been the mallard, averaging 30 percent of the total, while blue-winged teal made up about 18 percent. In the Dakotas and western Minnesota, the situation has been approximately reversed with blue-winged teal making up 38 percent and mallard only 16 percent. Why the difference? One piece of information related to the problem is the early fall migration of the bluewing which allows it to escape much of the heavy shooting pressure to which late migrating species are exposed. As a result, band recovery rates for bluewings are low from most breeding areas averaging less than 3 percent. In contrast, band recovery rates for mallards are much higher. However, except for periods when shooting regulations in the Central and Mississippi Flyways have been very restrictive, the recovery rate for mallards banded in the Dakotas and western Minnesota has been approximately twice as great as for mallards banded in the southern portions of the Prairie Provinces (Lensink, 1964).

Sowls (1955) and many others have determined that ducks have a strong homing tendency to natal marshes. An explanation of the difference in breeding population species composition between the Prairie Provinces and the Dakotas and western Minnesota is simply that excessive shooting of late migrating mallards in the stateside portion of the pothole breeding range has resulted in mortality in excess of production. As a result, mallards homing to breeding areas in the Dakotas and Minnesota have been materially reduced in number, while their Canadian counterparts have survived. On the other hand, due to early fall migration, neither the United States nor the Canadian blue wings have been materially effected by shooting and have survived to home to their respective breeding areas. Thus, what we might look on as a normal species composition in pothole breeding habitat with mallard as the dominant species has been upset in the Dakotas and Minnesota where the mallard and other late migrating species have suffered a mortality rate they could not overcome.

The idea that overharvest of late migrating mallards accounts for the difference in species composition between Canadian and United States pothole breeding range is supported by observations made in the vicinity of Minneapolis and St. Paul. Due to urban development, a two-county area in the vicinity of these cities is closed to hunting. Within the area, there is a good scattering of potholes and small marshy lakes. Casual observation demonstrates that mallard is the dominant nester in the two counties. This suggests that closure to shooting has provided sufficient protection that production has balanced mortality and a "homing" population of mallards has been maintained.

Finally, a summary by Arthur Hawkins (memorandum, 1963) of all available data from intensive studies conducted in pothole breeding range during the past decade reveals that acre for acre of wetland habitat, Canadian potholes produce ducklings to about four times the rate of United States potholes. Actually, if you accept the explanation concerning the difference in species composition between the two portions of the pothole breeding range, then a lesser rate of production would be expected in the Dakotas and western Minnesota, and for the same reasons. In any area where average mortality exceeds average production for one or more species, the breeding population with a "homing" instinct to the area will be reduced. This means that to a larger and larger extent the breeding population in a given year must be made up of birds basically enroute to another beeding area (in this case probably in Canada). Since the homing instinct is rather strong, any area that depends on attracting birds enroute elsewhere to make up a significant part of its breeding population will likely end up with a low density breeding population and low production. The difference of four to one in comparative production between Canadian and United States pothole habitat may be an exaggeration due to poor distribution of intensive study areas on both sides of the border. Nevertheless, there is a strong suggestion that overshooting of the indigenous breeding population is a potent factor affecting the amount of production per unit of habitat over broad areas.

You are all aware of the loss of critical duck breeding habitat and the problems this poses. To mitigate these losses to the greatest extent possible, Research has been assigned the responsibility of finding means of making "two ducks grow where one grew before." To accomplish this, many people are thinking in terms of new techniques for managing habitat. However, I believe that these techniques can have little beneficial effect unless within the general area where they are applied, the harvest rate can be held down to the point where survival of the local population can equal or exceed mortality. In the Dakotas and western Minnesota, it may be entirely feasible to materially increase production per unit of habitat by restrictive regulations within this area for a brief period of years. These restrictions might take the form of delaying the opening of the season until the local population has been diluted with migrant birds from further north. It should be noted, however, that in Wisconsin, Jahn and Hunt (1964) found that opening dates varying between October 1 and October 15 did not seem to effect the size of their breeding population, except possibly for wood duck. It may be that some solution other than delaying the opening date will be required. Regardless of the technique used, it will be gratifying indeed if the production of an important species like the mallard can be materially increased in a broad area with no more expense than is required to establish shooting regulations designed to protect the local breeding stock for a period of 3 or 4 years.

The Columbia Basin and the Dakotas-western Minnesota mallard problems have been discussed in some detail, because they illustrate types of situations which undoubtedly exist in other areas and within the populations of other species. They illustrate the need for detailed information concerning distribution during the breeding, migration, and wintering periods; for banding data so that mortality, including the portion due to shooting, can be determined for individual segments of the population; and the need for production rate (age ratio) information that can be related to each of these populations. Species management has many ramifications and can pay big dividends.

Species Identification by Hunters:

Another general field related to species management in which information is beginning to accumulate is the ability of hunters to identify waterfowl. It was discovered during the early days of the Waterfowl Kill Survey that if hunters were asked to supply information concerning the species of birds they killed, that a summation of their answers would agree surprisingly well with the actual species composition of the birds bagged. There were certain relatively minor but quite consistent differences. For example, the mallard was regularly over-reported, while some of the less numerous and less spectacularly marked birds, such as the gadwall and widgeon, were regularly under-reported (Geis and Carney, 1961) and (Jahn and Hunt, op. cit.). However, more intensive studies of the ability of hunters to identify birds have not been so encouraging. For example, Forest Lee (1956) conducted a study among 595 hunters in Minnesota in 1955 to determine their ability to identify the ducks they bagged. Approximately one-third of the total birds were misidentified with most hunters properly identifying such species as mallard, blue-winged teal, and lesser scaup, but less than half knowing such species as ringneck, baldpate, and gadwall. The fact that 64 percent of the hunters identified ringnecks as scaup combine with the fact that ringneck are more vulnerable to shooting than scaup as evidenced by much higher band recovery rates materially reduces the feasibility of bonus scaup regulations in many localities.

In some locations, it is quite obvious that hunters are able to identify species, or at least the species of major interest. For example, the majority of canvasback hunters around Chesapeake Bay are able to separate canvasbacks from other species and seldom kill anything else. Similarly, hunters along the gulf coast of Texas are able to identify and shoot mainly redheads. In both areas, restrictions in bag and then closure of the season on canvasbacks and redheads caused large numbers of hunters to cease hunting in spite of the fact that good populations of scaup were still available. Members of many clubs pride themselves in their ability to identify species. Penalties are sometimes assessed against members who shoot anything except drake mallards or perhaps bull sprig.

Additional data on ability to identify species comes from individuals who volunteer the identity of the bird as they report a band. Generally speaking, birds that are important in the bag within a given region are more frequently identified than are uncommon birds. To illustrate, in Wisconsin where the ringneck is not particularly important in the bag, 14 of 20 hunters reporting banded ringnecks called their birds scaup or bluebill and only 5 identified their birds as ringneck or ringbill (Jahn and Hunt, op. cit.). On the other hand, this species is important in portions of Louisiana and Florida and most of the banded ringnecks turned in from this area are correctly named.

Nevertheless, we must conclude that the ability of most United States hunters to identify waterfowl with the birds in hand is not good at the present time and is very poor when the birds are viewed in flight. If species management is to work in many situations, the birds must be identified in the air before the gun is fired. It does little good to discover a mistake after the bird is already dead. The fact that hunters in some localities have developed the ability to identify key species on the wing demonstrates that it is feasible.

SPECIES MANAGEMENT IN THE FUTURE

As human populations increase, the need for making more efficient use of all resources that supply recreation also will increase. Efficient use of the waterfowl resource for this purpose will necessitate refinement or development of a variety of techniques that can be lumped under the general heading of species management. Accomplishing this will demand considerable expansion in our knowledge about population dynamics, not only of each species but of population segments within species. Many of our current data collecting programs are aimed more toward continental or total flyway populations than toward specific segments within flyways. Also, our programs sometimes unintentionally emphasize major species, or at least those species about which information can be easily obtained. This is particularly true with banding because some species are much more easily trapped than others. Before species management can become more efficient, a considerable expansion will be needed in data collection programs with special emphasis given to several of the species that present difficult problems.

A major factor which will determine how far we can go with species management in the future will be ability of hunters to identify species before they shoot. Looking several generations into the future, there is a chance that efforts of people interested in waterfowl will be less successful in preventing inroads into critical breeding habitat. Populations of many important species may decrease, while pressure for recreational uses of waterfowl increase. Under such circumstances we can, perhaps, take a page from the history of hunting in Europe as a guideline. In many areas where game has become relatively scarce, hunting has taken on a ritualistic aspect where as much or more recreation is obtained from the rituals involved than is provided by the kills that are made. Perhaps this is going too far, but I can visualize a situation where the right to participate in hunting waterfowl will depend on the ability of the individual to identify species and where there might be as much recreation provided by learning to properly identify the birds as there is in the actual shooting that follows. In the meantime, there are many refinements in species management that are not dependent on hunters being able to identify species before they shoot. For example, data now available show that populations of some species are present in places and/or at times when they are not mixed to a significant degree with other species with which they might be confused. This is true for scaup in portions of the Atlantic Flyway. However, the Atlantic Flyway Council has gone on record favoring only those species regulations which can be applied flyway-wide. This materially reduces the possibilities for several types of species management practices in this Flyway and demonstrates that management by species involves people as well as the birds themselves.

In summary, we are dealing with individual species to a considerable extent at the present time in managing the waterfowl resource. As information accumulates to point the way, we will do more species management in the future. A stumbling block is lack of ability on the part of hunters to identify birds on the wing. Also, knowledge is lacking concerning the degree to which each of the apparently under-utilized species can provide additional harvest on a sustained yield basis. In many instances, there seems no way to increase our knowledge except to establish experimental seasons, and then evaluate the results. Fortunately, our data collecting programs have progressed to the point where we are able for most of the important species to measure mortality due to hunting, total annual loss, and the production ratio associated with various units of the population. We are now in a position to gather knowledge for refining species management practices. One word of caution, when an experiment is conducted, it may not necessarily result in an answer that demonstrates the feasibility of harvesting greater numbers of a certain species. Some people seem to have concluded already that blue-winged teal can withstand additional harvest, and they are looking on the proposed teal season next September as proper management and not as an experiment. We do not now know what the outcome will be. Everyone's understanding and cooperation is needed if rapid progress is to be made.

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DISCUSSION

MR. ALEX CRINGAN [Ontario]: I am a little disturbed about the speaker's implication that the laws concerning density dependence may not apply in case of waterfowl. I would like to ask to what extent the instance cited is actually supported by evidence that would demonstrate a marked change in population density with respect to the habitat occupied at the times in which the mortality factors were themselves operating. That is to say, is it not possible that we should look to the numbers of mallards per unit area rather than at the total population densities in North America as a whole? I wonder if a different answer might not come up if we examined the specific population densities in particular habitat types. In any event, with total mortalities of 71 per cent, I think that the 49 percent quoted in one instance is in effect a very large residual mortality and, again, we know very little about exactly when and where these natural mortalities occur. Therefore, I think we have a long way to go before we can say that these mortality factors are not density affected.

MR. CRISSEY: Your questions are difficult to answer specifically. On the one hand, migratory birds move from one habitat to another where during the course of a year an individual bird may be involved in a variety of population densities. On the other hand, our best measure of mortality comes from banding which yields a measure of average mortality over periods of time and cannot be related to specific habitats. However, in 1958 the fall flight of mallards was about 3 times what it was in 1962. It would appear that the density of birds in most migration and wintering habitats must have been considerably greater in 1958 than in 1962 yet in both years the loss rate due to causes other than shooting was somewhere between 10 and 20 percent. In spite of wide fluctuations in population density during the past decade we have not been able to detect a relationship between population density and rate of loss due to natural causes.

MR. AL GEIS: I would like to speak briefly to the last point concerning difference in mortality rates.

The speaker was concerned about the implication that mortality was not density dependent. I think this point might be cleared up by stating specifically the situation that occurred here.

With the 40 percent annual rate of mortality in contrast to 70 percent mortality rate, the entire difference in these two rates of mortality could be accounted for by shooting pressure. When you subtract the hunting mortality from the total mortality rate, the result is fairly uniform. It did suggest that with very high shooting pressures there was a slight tendency for birds to be shot that would have died had they not been shot. However, generally, the hunting mortality was in addition to, rather than in place of non-hunting mortality.

Also, I would like to underline something that Mr. Bossenmaier said—that when the data are published and available for people to see, they can then be in a much better position to criticize them. Of course, it is regrettable that these data are not available right now.

WATERFOWL HABITAT UNDER U. S. AGRICULTURAL PROGRAMS

D. A. WILLIAMS
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In reporting to you on "Waterfowl Habitat Under U.S. Agricultural Programs," I cannot speak as a technical wildlife specialist. I am not a biologist. But the Soil Conservation Service does have biologists on its staff, and they have provided me with some facts about what is being done in waterfowl management and conservation.

It is not my purpose, anyway, to delve into the specifics of waterfowl habitat requirements. Anyone interested in such technical details can find them in the attractive and interesting book, *Waterfowl Tomorrow,* recently issued by the Bureau of Sport Fisheries and Wildlife. Rather, I want to consider some general features of the waterfowl situation in relation to agriculture and the Federal programs that influence how land is used.

WATERFOWL AND AGRICULTURE

Agriculture contributes in a major way to good waterfowl habitat. Contrary to the widely held view, it is not the main threat, but the main *hope,* for abundant waterfowl and good sport with gun and binocular in the future. Four little-appreciated, but very fundamental, facts make this statement true:

1. *Most of the waterfowl habitat in the United States is on private land.*

This is a self-evident fact, since two-thirds of the total land area of the country and more than 90 percent of the Mississippi Valley and the eastern States, where the main waterfowl populations occur, is privately owned.

As I understand it, most of the ducks and geese originate in the vast areas north of the United States, beyond the influence of U.S. agricultural or conservation programs. The principal breeding grounds in our own country, which account for about 10 percent of the continental waterfowl population, are in the northern Prairie States, where nearly all the land is in private ownership and used for farming.

The wetlands and farmlands of the United States are the migration routes and wintering grounds of waterfowl. The four great flyways pass mainly over private land. In the West, the birds concentrate in the river valleys and on irrigated land largely in agriculture. Major winter feeding grounds along the Atlantic and Gulf coasts, in southeastern swamps and marshes and the ricelands of Louisiana and Arkansas, are mostly privately owned and generally associated with farming areas.

So it is axiomatic that the availability and the quality of waterfowl habitat depend largely on what private owners do with their land and associated water areas. The urgency of the current effort of wildlife agencies to acquire key areas for waterfowl habitat shows how much importance they attach to these private lands.

2. *Waterfowl depend on farm crops, and the effects of farming, for their presence and survival in the modern scene.*

It is easy, and perhaps only natural, to blame agriculture for preempting the breeding and wintering grounds of waterfowl as our Nation spread across the continent and required land to produce needed food and fiber. It might be asked with equal relevance if urban and industrial development have not occupied territories just as important.

But at the same time, agriculture has made other areas suitable for waterfowl use, so that most species have survived the change with good prospects for the future.

Biologists explain it by saying that waterfowl are mainly creatures of the early stages of ecological succession. They originally lived and bred in the developing vegetation along the edges of ponds and lakes. They fed on succulent aquatic plants and on the seeds of grasses and weeds that spring up on exposed mud flats, along receding shorelines, and in bottomlands scoured by flood waters. The stabilized marsh areas, the climax prairies, and majestic forests of primeval America were generally inhospitable terrain for waterfowl. The birds then were dependent on limited areas of youthful landscape, like the glacial potholes of the north, intermittent marshes, shifting stream channels, and swampy woodlands.

The migrating flocks today depend instead on the succulent forage and scattered grain, and on the seeds of weeds associated with cultivation, in cropland fields carved out of the original prairies and forests. Farm ponds and other impoundments, including irrigation developments, add surface water and shifting shorelines to the landscape in places where they were unknown a century ago. Anyone who has witnessed the great concentrations of waterfowl in the rice fields of the South or the irrigated valleys of the West cannot question that agriculture not only has shifted the pattern of waterfowl distribution in North America, but has provided for its survival.

3. *Soil and water conservation practices on agricultural land help improve waterfowl habitat.*

The importance of agricultural practices to waterfowl habitat is further demonstrated by the extent to which they are used on waterfowl refuges. Isn't it significant that as soon as a tract of land is taken out of private ownership and placed under specific management for waterfowl, one of the first things the manager usually does is ask the Soil Conservation Service to help him plan a farming program and design water-control structures to assure continued production of waterfowl food? The SCS is pleased to be of service in planning waterfowl management programs for these important areas.

As an example of what they include, here is a summary of soil and water conservation practices established on the Bombay Hook National Wildlife Refuge on the Delaware coast:

4½ miles of open drainage ditches
4 water-control structures
7 acres of land grading
10 acres of land smoothing
242 acres of brush removal
1,100 acres of cover and green-manure cropping
1,200 acres of conservation cropping system
1,000 acres of crop residue used to leave cover on the land for wind erosion control and wildlife food
645 acres of wildlife habitat improvement by seeding shrubs and lespedeza
15 acres of proper use of pasture

We also assisted with plans for several hundred acres of wildlife wetland development.

This technical service was provided by the SCS and the practices were established by the Fish and Wildlife Service under an agreement with the Kent Soil and Water Conservation District in which the refuge was treated as any other landowner.

Of course, we realize that this particular work is of unusual value to waterfowl because of the strategic location of the land and the fact that the practices were designed specifically to benefit the species of concern. But I would like to point out that these same practices, and others equally important, are widely used by private landowners in soil conservation districts all across the country. Not only is this true for water management, but also of millions of acres of cover cropping, crop residue use, proper grazing of pasture and range, woodland protection and improvement, and wildlife habitat development.

Another important practice—one not needed on the Bombay Hook refuge but used on others and widely applied on farms and ranches—is the construction of ponds and other small impoundments of water. Soil conservation districts report 1,389,383 farm ponds and reservoirs on the land. In addition, most of the seven thousand floodwater retarding structures that have been built result in sizable impoundments. The value of these small bodies of water—something recently added to the American landscape—for resting, nesting, and feeding sites for waterfowl is recognized by several of the articles in *Waterfowl Tomorrow.*

It is obvious that the combinations of soil, water, and vegetation management practices to produce a given result must be adapted to each particular land area, whether the use be primarily for wildlife, for agriculture, for recreation, or other purposes. The multiple-use concept is especially significant for combining agriculture and wildlife uses.

Waterfowl sanctuaries on public lands, and the management practices associated with them, are, of course, the nucleus of the national waterfowl conservation effort. They are designed to protect and enhance the key areas used by waterfowl. But we can scarcely hope that sufficient funds—or land areas—will be available for this purpose in the future to assure a satisfactory waterfowl population. The major part of the Nation's waterfowl habitat must continue to be provided on private land in close association with agriculture.

4. *Agriculture and conservation practices on private land make more waterfowl available for the enjoyment of more people.*

Not only do agriculture and conservation practices improve waterfowl habitat, as I have just described, but they create favorable environment in places where it did not exist originally. As a result, the waterfowl population is becoming more and more widely distributed where it can be enjoyed by growing numbers of hunters and nature enthusiasts. As private landowners and local communities progress in their conservation programs, we can expect even wider dispersal of waterfowl in the future.

Meantime, hunters are turning more and more to private areas where, for a fee, they are assured of good shooting under careful control on grounds that have been made attractive to waterfowl by intelligent management. Waterfowl are no exception to the rule that hunting will be available in proportion to the incentives landowners have to provide it. Fee hunting in its various forms offers those incentives.

But waterfowl, like other wildlife, is not for hunters alone. A growing interest in the outdoors, in bird-watching and other forms of nature study, gives new importance to our waterfowl resource. These people, even more than hunters, are gratified by the sight of an itinerant flock of teal landing on a farm pond or the V of geese passing overhead in sections where waterfowl were seldom seen before.

THE AGRICULTURAL PROGRAMS

The foregoing makes it clear that the destiny of waterfowl in this country rides with the destiny of agriculture. Wildlife agencies, therefore, are properly concerned with the programs of the Department of Agriculture and their effects on waterfowl habitat.

Let me briefly review the current programs of interest in this connection:

Cropland conversion. A major effort of the Department today is to divert land from cultivation to other uses that generally require establishment of permanent vegetation. There is a specific "Cropland Conversion Program" under way in a few counties on a pilot basis, but all Department activities are being oriented, wherever they can be, to reduce the production of surplus farm commodities.

To the extent that these efforts are effective in bringing about major regional shifts in cropland acreage, they can be expected to have an influence on waterfowl distribution—especially on the migration routes and winter concentrations of the more abundant species.

Soil Conservation Districts. I have already mentioned the extent of conservation practices applied by private landowners in soil conservation districts. As you know, the Soil Conservation Service provides on-site technical service to land owners and operators through these local units of government. Wildlife agencies and all other conservation groups have an opportunity to reach private landowners through this same mechanism.

Small Watershed Projects. Small watershed projects under the Watershed Protection and Flood Prevention Act provide a way for communities to plan and execute coordinated land treatment and water control programs for complete watersheds. Federal assistance can now be made available for fish and wildlife developments and recreation facilities in these projects. Procedures have been established to inform wildlife agencies of proposed projects in time for them to make recommendations for the plans, and to refer stubborn questions to an inter-agency committee. More than 600 projects have been approved for operations and 400 others are in the planning stage.

Agricultural Conservation Program. The Department's program of sharing with land owners or operators the cost of specified conservation practices deemed to be in the public interest includes some for the specific purpose of improving wildlife habitat, such as marsh development and water impoundments. In addition, most of the soil and water conservation practices that qualify for cost-sharing, just as those in soil conservation district programs, benefit wildlife.

Conservation Loans. Loans by the Farmer's Home Administration to help landowners pay for needed conservation work, or to help local communities finance their share of small watershed projects, advance the objectives of those programs and get more conservation on the land. In addition, FHA helps finance individual and group recreation enterprises on private land, which often include ponds and other wildlife developments.

Resource Conservation and Development Projects. A new type of long-term community-wide conservation effort is the Resource Conservation and Development Projects now getting under way in 10 pilot areas. These, like the smaller-scale watershed projects, are locally initiated and directed. They are based on comprehensive plans for coordinated resource use for entire areas usually larger than a county. These programs are aimed at economic improvement of the community through resource development, and some place great reliance on fish and wildlife improvement and recreation enterprises. The opportunities of this approach merit serious consideration by wildlife interests.

NEED FOR COOPERATION

The Federal agricultural programs offer tools by which individual landowners and communities, acting in their own interest, can accelerate land use adjustments and the application of conservation practices to the land.

In general, the effect of these programs is to protect land and water resources and sustain wildlife populations. The particular kinds of wildlife favored depend on the local circumstances and, to a considerable degree, on the interests and designs of the land owners and operators.

I was impressed by a report of the Farm Game Committee of the Southeastern Section, Wildlife Society, that recently came to my attention. The opening sentence said:

"One of the thorniest problems facing the game biologist and wildlife administrator today is the effective management of our farm game species *on a state or region-wide basis* (emphasis mine). This is ironic because it is generally known how to increase wildlife populations on a given unit of farm land, but to materially raise population levels over large areas of varying ownerships is a different story."

This realistic statement recognizes a fundamental fact of American land tenure and land use—the fact of independent determination by individual owners of how the land shall be used and managed. To motivate the owners of a state or region to move in concert in their land management practices over a large enough area to have the desired effect on wildlife populations is indeed a big order. And when the species involved are migratory, as are waterfowl, the problem is many times compounded.

We have met this problem with some success in conservation of soil and water—which pay no more attention to property lines than wildlife—through the medium of soil conservation districts and small watershed projects that enable the local people to agree on common purposes and use available technical services and financial aid to achieve them. The same mechanisms are available to wildlife conservation efforts, and I believe they offer the best means at hand for improving waterfowl habitat.

The Farm Game Committee report goes on to make a plea for cooperation and coordination "between all agencies involved in the various phases of land use and wildlife resources"—a plea to which I heartily subscribe. If we want neighboring landowners to coordinate their land management practices to achieve a certain effect on wildlife populations, must not the agencies that seek to influence their actions themselves present a unified appeal to those who make the decisions?

The Soil Conservation Service is anxious to participate in such a coordinated effort in all aspects of resource conservation, and is working constantly to that end. We invite every wildlife agency to make known its interest in any land use or water management project for which we have a responsibility, the same as we invite any other group to make its interests known. We welcome the presentation of any factual information about any area and the probable effects of alternative proposals.

In all our operations—whether making recommendations to the operator of a small farm, to the sponsors of a watershed project, to an urban planning commission, or anyone else—we base our policies and actions on two fundamental principles:

1. Consideration of all pertinent information about the physical resources of the area; and

2. Consideration of the needs and desires of all the people with a valid interest in the area, with due respect for the property rights of the owners and concern for the public welfare.

Naturally, such an appraisal of any resource-use problem is likely to bring to light differences of opinion and of interest. It is not always possible to find a solution that will satisfy all concerned. The best that can be done may be to honestly evaluate the alternatives and leave the choice to those responsible for making the decision—the landowner, the community, or the responsible governmental body, as the case may be.

If the recommendations of wildlife interests are to carry their proper weight in such appraisals, they must be made in the spirit of cooperative planning and multiple judgment that must govern. The Soil Conservation Service, as a Federal agency, cannot place the interests of one group of people above another, or consider one segment of the resource complex by itself. Neither can any other Federal or State agency; to do so would be to violate the principles of democratic government and the fundamental facts of resource ecology.

So I hope we can continue the good work that has been so well begun on the farms and ranches and in the watersheds of our country to conserve and develop the land and water resources—including wildlife of all kinds—for the use and enjoyment of all people. The record is clear that waterfowl habitat can be maintained and improved by these measures. With the understanding participation of wildlife experts and lay conservationists in well-planned coordinated conservation efforts, we can be assured that waterfowl can flourish and grace our land in the future.

DISCUSSION

VICE CHAIRMAN ANDERSON: Perhaps we cannot blame the waterfowl biologists for being still suspicious and scared of SCS because of the vast amount of draining which, rightly or wrongly, we seem to attribute to SCS. However, it should not be necessary to remind a waterfowl biologist that the man who makes the final decision as to how the land will be used is the landowner. Whether we like it or not, we should be willing to admit that wildlife management was in its infancy when soil conservation left the campuses and the state capitols and took their new findings in agriculture research out to the land and got it translated into land management.

We have now reached a stage where we have enough knowledge of waterfowl management to tell the landowner that if he will follow this, he will be increasing the carrying capacity of his lands. We cannot afford the luxury of saying: "I will get the knowledge and I will keep it to myself." I think this would be a fine way to grow a real crop of picnic tables and summer cottages. It has come to my attention that a Southwestern Minnesota farmer has taken advantage of the very things that Mr. Williams has outlined. Perhaps I can call on Mr. Thompson here to tell us about his experiences in this regard.

MR. THOMPSON (Minnesota): I am in farm management. Farming is my background and agricultural income is my business interest.

We had a farm that was drained almost entirely in the early forties and we ran out of money toward the end of this draining project. We left probably the most desirable gully on the farm undrained, and this was shot by people pretty carelessly and without any management whatsoever in the interim period between 1940 and to date, or until last fall. At that time we thought that perhaps, in view of the fact that drainage plans were blueprinted, it would be possible to determine by some sort of an economic formula what sort of recreational or hunter income we would need to replace the net agricultural income that would be achieved if we drained every slough.

Well, we worked on this particular project and we came up with a fairly good formula which, at any rate, still has a few loopholes in it. It is too difficult to explain here, but the amount of net recreational money we needed to lease this out to interested hunters was not excessive and as a matter of fact, we had very little trouble getting four hunters and two of their sons to take this property over on a lease basis. This was on the basis of a lease that required that both the owner of the farm and the lessees would contribute together toward a management program which would include many of the things that Mr. Bossenmaier mentioned earlier.

Granted, we certainly are not particularly well qualified to make the decisions management-wise, but we do have the interest and I am also including myself in this, with the four men who have leased the property, as well as their two sons.

Now, Mr. Jim Kimball, of the Minneapolis *Tribune*, became interested in this and kindly wrote up an article that appeared in the paper and, as a result, there was quite a response from farmers and from city people to the program I have briefly described. I think perhaps the easiest thing I could do at this point might be to read just a few lines from one of the more expressive letters that came in. This is from a Mr. Murray:

"I would like to see the lands preserved in more or less their natural state and to provide habitat for as much wildlife as possible. I am concerned with the fact that the character of our land is changing so fast that in a few decades there will be little land of the rural type common a few years back and public hunting and enjoyment of nature will be restricted to a little government land set aside for that purpose, as well as to private hunting clubs. Your idea could help change this prospect.

"I have been thinking that I would run some classified ads in a few smalltown papers in the area which I am interested in and that this might provide me with the leads that would solve my own personal problem. However, this would be just a drop in the bucket compared with what should and could be done. I am sure that the hundreds or even thousands of sportsmen and farmers could be gotten together. The question is—how can it be done on a large scale and on an efficient basis so that the land involved is not just an isolated parcel here and there?"

He then goes on with a few additional words here which anybody is welcome to look at.

I might say that we did one thing in process of setting up the formula. We went to the SCS and although this drainage project would not have called for SCS or ACP aid, we had technicians estimate the cost o draining the project and to determine the difference between the appraised value of the land estimated and to what it might be appraised at once drained. Then, from this, we deducted the cost of drainage and applied the average net percentage return factor or agricultural investment in our area. This seemed to be a very simple means of determining rental that would give the farmer a return equal to what he might get if he did not drain the slough.

VICE CHAIRMAN ANDERSON: Here is a landowner who has proven by leaving his wetlands wet that he could make more money than if he drained them, simply by renting it to hunters and charging them for the right to hunt on it.

I am also happy to indicate that I am aware that South Dakota has cooperated with the SCS and I think they are effectively restoring a lot of waterfowl habitat there. I also understand that some of the other states in the North Central Region are doing likewise.

PRIVATE CLUBS AND THE WATERFOWL RESOURCE

WALTER T. SHANNON [1]
Director, California Department of Fish and Game, Sacramento

One of the major problems of waterfowl management throughout the North American continent is the continual loss of wetlands or living space for waterfowl and other marsh wildlife. This situation is also very apparent in California.

In recent years drought conditions on some of the major waterfowl breeding areas have caused further reductions in the amount of habitat available to waterfowl. The eastern flyways have been especially hard hit, both by the drought and other continuing losses of nesting habitat. The Pacific Flyway has also been affected by poor nesting conditions, but on the whole the breeding grounds for this flyway are in better condition than on the other flyways. In our flyway the greatest need is for preserving and improving the wintering grounds. Since the majority of birds on the Pacific Flyway winter in California, the need for preserving the State's wetlands becomes increasingly important.

It has been estimated that in the early history of California there were about 5 million acres of wetlands. Probably about 3½ million acres could have been considered as good waterfowl habitat. The Wetlands Inventory, taken in 1954, showed that these wetlands had dwindled to about one-half million (559,000) acres. Of this remaining habitat about 300,000 acres are in privately owned duck clubs, and most of the remainder is on the state and federal waterfowl areas. In addition there are nearly another one-half million (495,000) acres of seasonally flooded agricultural land that provide good habitat for waterfowl. Most of this habitat is comprised of rice lands and intermittently flooded pasture lands. At the present time these lands carry a large portion of our wintering waterfowl, but we cannot afford to become too dependent on these lands as their status could change at any time. In the future it is quite possible that a change in crops, agricultural practices, additional flood control, or more adequate drainage could easily eliminate waterfowl use on these lands.

There are other threats to our wetlands. Every new dam, flood control, drainage, or marsh filling project poses a direct threat, or more often an indirect threat, to waterfowl habitat. All of this is brought on by the economic pressures of agriculture, industry, and urbanization as our human population continues to grow.

Some means must be found to perpetuate our rapidly dwindling wetlands. Anderson and Kozlik (1964) have pointed out the impor-

[1] In the absence of the author, this paper was read by Mr. Ben Glading.

tance of the private duck club lands to the waterfowl resource. Many of these points bear repeating, and in addition I would like to present some methods that might be used to maintain these privately owned wetlands.

While many have damned duck clubs as being the stronghold of special sporting privileges, we are interested in the amount of habitat that they are preserving. In fact, the objectives that many of these clubs are accomplishing parallel those of the state and federal waterfowl areas, namely that of maintaining habitat, controlling waterfowl depredations on agricultural crops, and providing hunting. Naturally, in the case of duck clubs, their main objective is hunting, but the other benefits to the waterfowl resource are present nevertheless.

At one time crop depredation by waterfowl was one of our major problems. Many factors have helped to alleviate this problem, but duck clubs have played one of the key roles. Each year as pintails begin to arrive in late summer from the northern breeding grounds, agricultural crops (mainly rice) are endangered as the birds look for food. During the early 1950's it was necessary to use artificial feeding of grain to keep the ducks out of the ranchers' crops. This practice was carried on as a coorperative effort on both the public waterfowl areas and on duck club lands. Now with more state and federal areas and with more food also being raised on the duck clubs, the depredation problem is controlled by natural means. The club lands are especially attractive to the early arriving ducks as the areas are progressively flooded and float up an abundance of seeds and insects.

With the start of the hunting season, the clubs use management practices that not only improve hunting success but also benefit the resource. The larger clubs that can spare the acreage set aside rest areas or refuges where the birds are not molested. Waterfowl population surveys made during the fall and winter show that some of the duck clubs in the Butte Sink of the Sacramento Valley consistently hold more birds than the state or federal waterfowl areas. Nearly all duck clubs hunt only on the traditional shoot days of Wednesday, Saturday, and Sunday. Many clubs shoot only on the weekends. During the non-shoot days waterfowl make good use of the entire duck club.

The duck club properties probably play their most important role after the hunting season closes. At that time waterfowl spread out from the refuges and rest areas to take advantage of all available habitat. Usually by this time the winter rains have provided additional water, and the wintering grounds reach their peak condition. It is necessary that good water and feed conditions be maintained so that waterfowl will return to the northern nesting grounds in good breeding condition. Some clubs also furnish nesting habitat, but the number of nesting ducks is relatively insignificant when compared to the millions of wintering birds.

One way that we are trying to compensate for the loss of habitat is by increasing the carrying capacity of the remaining wetlands. Many of the duck clubs are only partially developed, but by improving their holdings the clubs will be able to carry more birds.

The Department of Fish and Game technicians and the Soil Conservation Service districts encourage duck clubs to improve their habitat by proper water manipulation, raising aquatic foods, and controlling the undesirable cattails and tules. Clubs are also informed that such highly advertised duck foods as wild celery and wild rice do not thrive under California conditions. It is significant to note that in two Soil Conservation Districts nearly every member is a duck club owner, and that there are other districts with many members owning clubs.

Most duck clubs are anxious to improve the habitat that they control, but the lack of water usually prevents any large-scale development. Nearly all of California's rainfall comes during the winter months, and the rest of the year plant growth is dependent upon irrigation water. In some sections of the state water becomes available to duck clubs at a reduced price after the agricultural crops are harvested. In other localities duck clubs are able to obtain irrigation drain water. Still other clubs are dependent upon wells, but usually pumping costs are so high that water is ponded only for the hunting season.

Water that is specifically designated for wildlife has only recently been officially recognized. Water for the duck clubs of the Grasslands Water District has received such recognition. When Friant Dam was built to hold back the waters of the San Joaquin River, the U.S. Bureau of Reclamation purchased the water rights below the dam. Such action threatened the very existence of the Grasslands duck clubs, which were dependent upon the San Joaquin River for their water. Considerable negotiation and litigation were climaxed by the introduction of the Grasslands Bill into Congress. In 1954 the bill was passed and became Public Law 674. It reauthorized the Central Valley Project, giving consideration for fish and wildlife; and, of most importance to the Grasslands duck clubs, it provided water for waterfowl purposes after the agricultural growing season at reduced rates.

From what has been covered so far, it has been shown that we realize the importance of the duck clubs and that we are encouraging the improvement of these wetlands. However, our big problem is to see that these lands remain as waterfowl habitat. Severe economic pressures are being brought to bear upon these clubs as the competion for land increases. The rates for real estate taxes are continually rising and the clubs are being assessed at higher appraisals than adjacent lands. Instead of being recognized as serving a conservation purpose, the clubs are being further penalized with excise taxes. To remain in operation, many clubs are going in for multiple land use instead of concentrating their efforts just on the hunting season. Others, though, are simply ceasing to operate as duck clubs.

At the present time we are exploring a number of ways that might be used to preserve our dwindling wetlands. Some people feel that the only way that wetlands can be perpetuated is through acquisition by the state and federal governments. However, the extremely large amounts of money needed to purchase these lands would be nearly prohibitive, and this would still only be a start. Each year additional funds would be needed to operate and maintain these areas. We have experienced just such budgetary problems in managing new wetlands that were turned over to us by another government agency.

Another proposal that is quite similar to the above would have the state or federal government acquire the lands, but then lease them back to the original owners with the stipulation that they must be maintained as wetlands. The government would still have the large cost of acquiring the lands, but there would be some return from leasing, and the operational and maintenance costs would be the responsibility of the lessee. In turn, the lessee would realize some return from the land, retain hunting and recreational benefits, and obtain relief from taxes.

Still another possibility for perpetuating wetlands is through an easement or lease. Under this system a landowner would be paid a certain amount per acre for maintaining waterfowl habitat. Such a practice is now being used by the U.S. Bureau of Sport Fisheries and Wildlife to maintain potholes on the waterfowl nesting grounds of Minnesota and the Dakotas. In California such easements might be attained by other means, namely, substituting water for cash payments. We have already discussed how additional water might be used to improve existing habitat, but where water is scarce or costly it can also be the means for encouraging landowners to keep their holdings in waterfowl habitat. Subsidizing landowners for performing certain agricultural operations is common practice today. There is no reason why wildlife crops cannot be supported in the same manner, and in many cases cash subsidies would not be necessary. Most clubs could be subsidized for maintaining waterfowl habitat by furnishing them an adequate supply of water. In some areas this could be irrigation drain water that is no longer good for farm crops but is still fine for waterfowl purposes. In other places where there is surplus water from water projects, such water could be made available for wildlife purposes. Also, where water projects sponsors plan to sell water at preferential or subsidized rates to agricultural interests, water at similar rates should be available for managing waterfowl habitat. Another means of recognition that could be given to duck clubs for preserving habitat would be a reduction in real estate taxes. For the same reason the excise tax on duck clubs should be eliminated. We are hopeful that Congress will take such action during the current session.

The simplest method for retaining wetlands would be by zoning. However, most zoning is handled by local planning commissions and there are no uniform means for classifying lands. Some boards are now zoning certain lands for recreational purposes, but very little wildlife habitat is being recognized or set aside for that purpose.

Eventually a combination of methods will probably be used to maintain our wetlands. Some key areas will need to be acquired by government action. In other areas leasing will be an adequate means of preserving habitat, and in some places subsidies may suffice. In all of these endeavors it must be remembered that a duck club's primary purpose is to furnish duck hunting. Without the incentives of reasonable seasons and bag limits, many clubs will quit operating as their lands lose their recreational value. Once wetlands are converted to other land uses they are irretrievably lost. If we are to preserve our waterfowl resource, the private landowner must be encouraged in every possible way to maintain the habitat he now controls.

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DISCUSSION

VICE CHAIRMAN ANDERSON: Thank you very much, Mr. Glading. It is extremely gratifying to find a state wildlife administrator who seems willing to help the private landowner maintain his own waterfowl habitat. Too often state and federal administrators seem to cringe in horror when they find a private land owner who wants to preserve waterfowl habitat on his own. One possible explanation of this may be that many of these administrators are thinking in terms of the thirties. They feel it is their sacred duty to provide free hunting to the one-gallus hunter.

Of course, this is not right because the one-gallus hunter, so called, in this affluent society, is making more money than the average wildlife biologist and, therefore, is perfectly willing to spend his money for the privilege of hunting which, in turn, will preserve the habitat if we would get over the antiquated notion that there is something unholy about expecting hunters to pay for the privilege.

California obviously is facing this problem squarely, I think, and, also, we are fortunate that Ben Glading and Mr. Shannon have this attitude.

WATERFOWL CONSERVATION IN MEXICO

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INTRODUCTION

Conservation and systematic wildlife regulations in Mexico are relatively new, as corresponds to a country under intensive social and economic growth, with a high rate of population increase, and where living and educational standards are also changing very rapidly. Progress in wildlife management—and, especially, any protective measures for waterfowl in its wintering habitat—becomes in this way a part of the general development of the nation.

In this connection, the first really important game regulations appeared as recently as 1931, in the presidential decree prohibiting the shooting of "armadas," establishing heavy fines for violators, and specifying the requirements for duck hunting.

The next important steps were, no doubt, the Migratory Bird Agreement signed with the United States in 1936, and the publication of the first hunting calendar, with seasons and bag limits for most species, in 1937. The Game Law of 1940 was also a highlight in the development of wildlife management, although it still maintained commercial hunting as a legal activity. In January, 1952, revised and improved regulations appeared, defining all kinds of game as a natural resource, belonging to the nation as a whole—and banning all commercial hunting and the "sale, bartering or advertising of all meat, products and remains of wild animals." Since that date only sport hunting is within the law.

Parallel to these legal advances a very important administrative change deserves mention: the small and unimportant Game Office —then a part of the Forestry Department—was given in 1959 the rank of Game Department, with category of its own and a better budget. And soon, in 1961, the Game Department was again changed, to become the Wildlife Department (*Dirección General de la Fauna Silvestre*), moved to new headquarters, and given a special library and laboratory as implements for the necessary research and field studies in support of the regulations. And this is not all. The present Wildlife Department is again in preparation of future progress in the way of legal, technical and administrative procedures, and in the means and personnel for the enforcement of the law.

Since so many modifications have taken place in the last few years, we considered it important to give this information as background for the report of activities that follows. It will help for a better interpretation of what Mexico is doing for the protection of waterfowl wintering in the country, and of our plans for future developments, in which Canada, the United States and Mexico are mutually interested.

ACTIVITIES DURING THE 1964-65 SEASON

As has been repeatedly stated, Mexico contributes substantially to continental waterfowl conservation through its wealth of wintering habitat. This is particularly true in relation to the coastal grounds with numerous bays and marshes, along the Gulf and the Pacific Ocean. It is also true over the high lands, at least during the wet or "big snow" years of the weather cycles of North America. For geographic and topographic reasons, climatic conditions in the country change from year to year. And the months covered in this report belong to a humid period of the cycle.

Most of the natural lakes and water reservoirs of the Central Plateau and the Northern High Lands were full to capacity, and general habitat conditions greatly recovered. As a result of this—and, probably, also because of heavy snow fall in the North—the winter concentrations of waterfowl were greater and more diversified than in previous years. Waterfowl also were seen earlier in the fall. Impressive concentrations of geese could be seen early in October overflying the water storages close to the border. Whitefronts, lesser "Canadas" and snow geese predominated. Heavy flocks of ducks were seen coming to the Central Plateau, the upper Lerma Valley, Lake Zumpango and the ponds representing what remains of old Texcoco Lake. Many pintails, baldpates, shovellers, blue-winged teals, and even canvasbacks could be seen. Unfortunately we do not have yet in our Wildlife Service the necessary equipment and facilities for counting—or, at least, estimating—waterfowl concentrations. But surveys from the air and reports from hunters indicated a special year for the High Lands. And, most probably, a similar situation prevailed along the coasts.

This increase in the winter visitors was favorable to the reappearance of some "armada" shooting, particularly in Lake Texcoco, making necessary the reinforcement of the patrol work, with the personal participation of the Director of the Department himself. Many heavy-caliber guns and long nets for large-scale capture of ducks and other waterfowl were confiscated. Some of these nets extended for more than a mile over the water and could be picked up only by skillful helicopter maneuvering. The helicopter was also employed regularly for conservation and detection, and even for law enforcement tasks, when necessary.

From the technical point of view, special interest was centered on

Lake Zumpango and "Charco de Atenco," the latter being a rather small but very important water impoundment, at the east of the City, collecting the streams of the Papalotla river, and a remnant of old Texcoco Lake. The present situation and the evolution for the near future of these lakes were repeatedly discussed with the Hydrologic Commission of the Valley of Mexico, to see that they include waterfowl utilization and problems in their regular programs, which they finally accepted. This decision is considered of special significance, since for the first time in Mexico the Department of Water Resources has given consideration to waterfowl protection, which is, virtually, the introduction of a multiple-use policy for their projects.

It is also very important because it is worth remembering that our Undersecretary of Forestry and Wildlife (*Subsecretara Forestal y de la Fauna*), has always shown much interest in the restoration of Lake Zumpango and, at least, one or two of the small lagoons remaining of Lake Texcoco. And Atenco has shown certainly wonderful possibilities. It is clear that a wintering refuge in the Valley of Mexico and close to the City has definite advantages even if the lakes are small. According to our line of work, Atenco will be the first officially declared National Wintering Refuge for waterfowl in the country, and its location will give it great educational and demonstration effects. And, in addition to this, we must not forget that the high lands have suffered the greatest habitat degradation, so that activities for the restoration and protection of these areas become automatically highly significant.

This is why we are pleased to report now that, since 1964 and in preparation of the budget for this year, the Subsecretaria has allocated 135,000.00 pesos (about 11,000.00 dollars) for the studies of habitat (particularly of vegetation, soils and water), for the acquisition of a special patrol vehicle and corresponding equipment, and to hire a couple of wardens for the permanent protection of Atenco and the surrounding area. This budget has been confirmed by the new authorities of the Subsecretaria so that we are now practically in operation.

And, as for Zumpango, it is interesting to report that, as a result of the discussions previously mentioned, the construction of a derivation channel from the Cuautitlán river was accelerated and is now in use, with enough capacity to maintain at least the northern section of the lake with sufficient water and aquatic vegetation the year round.

In regard to these two lakes, and considering the efforts already made by the Mexican Government, it is hoped that the arrangements initiated with Ducks Unlimited and left uncompleted last year on account of our changes in public administration, can be resumed as soon as possible. It is obvious that any financial help now, to implement a long-term program of constructions and installations or for technical work, will mean the consolidation of what really is the *first wintering refuge in Mexico* (if not in Latin America), as a magnificent example for the future of waterfowl management.

A few last words in regard to Atenco. A trial banding program, also the first to be operated in Mexico, is being presently prepared to begin next fall.

Speaking of related academic activities we also have something to report. Our Department has had the opportunity to participate in a series of round-table discussions on the Utilization of Water in Mexico, convened by the Mexican Institute of Renewable Resources. We pesented a paper on the "Value of Water in Regard to Wildlife and Recreation" in which, as a result of the analysis of the main problems, emphasis was put on the policy of multiple use of land and water, and on the great social and economic significance of waterfowl for the country.

Referring to particular migratory species, although not related to waterfowl in its usual meaning, it is interesting to inform you of the tablishment, in June of last year of the Isla Rasa National Refuge, for the protection of the Heermann gull and the elegant tern. This project was possible thanks to the collaboration and financial support of the National Audubon Society and the Subsecretaria, and the academic and administrative help of the Institute of Renewable Resources.

Finally, a special project was started last year by the Fisheries Department of the Secretary of Industry and Commerce, which will certainly have implications for waterfowl management. We refer to the control of aquatic surface weeds, notably water-hyacinths. They are now planning to use mechanical and chemical means, especially the first, for the control of the weeds. Unfortunately, they began by trying an herbivorous species, the manatee, of which six were transferred from the coast of Tabasco to Lake Chapala. Two of them died soon after arrival, and the other four are seemingly doing all right. But they have been showing a definite preference for submerged vegetation, apparently leaving the lilies as a last resort.

FUTURE PROGRAM

Since we are now beginning a new cycle of Public Administration, a program has been presented to our higher authorities, to continue the development of the technical and social work of the Department, and to complete the projects of the last recent years.

In the first place, the legal status of the land around Atenco and

Zumpango is being investigated, in order to propose the presidential declaration of either one or both as National Wintering Refuges. The restoration of the habitat and the protection (fencing) and re-forestation of the surrounding areas are also been planned, to be presented in future discussions with the Hydrologic Commission of the Valley.

In the second place, since thus far little work has been done in Mexico for the study of the coastal bays and marshes (serving as natural refuges), we are contemplating new phases of collaboration with the Institute of Renewable Resources. This would be particulary timely, because we have to remember that the Gulf and the Pacific coasts are becoming the subject of plans for economic and technological development, with the consequent deterioration of the—up to the present—isolated wetlands.

And finally, since sport hunting of waterfowl is rapidly gaining adepts in Mexico, we are already studying and preparing the necessary modifications of our Federal Game Law, with provisions to obtain from the hunters a special contribution—similar to the so-called "Duck Stamp"—specifically designed for wildlife development and protection. This modification we expect to send to the Congress during the next legislative term, and should bring additional money to implement our projects for waterfowl.

All this makes us feel confident to say, as final words of this Report, that Mexico is now on the way of steady progress in the conservation of waterfowl. Our government is striving very sincerely to come to terms with the provisions of the International Agreement and with the valuable efforts of the other interested countries.

DISCUSSION

VICE CHAIRMAN ANDERSON: It is gratifying to see that not only our United States Government but our private conservation agencies are already working hand in glove with the Mexican Government. This is a very encouraging report you have given us.

I have one question of Dr. Hernandez Corzo. Sir, the rumor still persists that occasionally American hunters go south of the border and kill large numbers of waterfowl. Is this, in your opinion, significant or is it grossly exaggerated? We do not seem to get banding checks but we still hear the story frequently and I suspect this is one of the questions that comes to mind.

DR. CORZO: I think that you have posed a very important question.

As a matter of fact, every year, Americans go down to Mexico as hunting tourists, especially interested in duck and geese. There are not very many, but the ones who go usually do not pay any attention to the bag limit. Naturally, it is not only their fault but our fault also, because I know their Mexican guides usually tell them they do not have to pay any attention to any laws—that hunting in Mexico is quite free and that we do not have hunting regulations.

Of course, it is true that not very many American hunters go every year but then, each year, a few more believe that you can go down there and shoot as many geese as you wish. This is likewise true of other animals, and so it does result in some problems. Therefore, we would like to have the cooperation of American authorities in informing Americans that Mexico really has hunting regulations as strict as yours and that everybody should comply with them.

In the second place, I think it is important, because of the bad example that it gives to Mexicans and to your people, when hunters who comply with regulations here cross the southern border and believe they can forget all about our regulations and laws. This is really a bad example for both your people and our people.

Therefore, I am grateful for the opportunity to be able to discuss, even briefly, this important matter and I thank you all for the opportunity of being able to present the views here and again request your cooperation.

WATERFOWL HABITAT PRESERVATION

JOHN S. GOTTSCHALK
Director, Bureau of Sport Fisheries and Wildlife, Washington, D. C.

In the wildlife management equation, habitat is the ultimate factor. No one in this audience needs to be reminded of this elemental truism. Yet I believe it desirable to begin this commentary on the Federal efforts at wetlands preservation with a reference to the fundamentals, and to the philosophy of government action which these fundamentals support.

Wildlife management, tersely defined, is merely the use of discretion, the making of choices, based on the best facts available. In our management of waterfowl in recent years we have placed great emphasis on the construction of a research program designed to give us the tools needed to get these facts. We have elaborated an extensive and involved set of machinery to secure the knowledge, the lack of which in our earlier years made the administration of waterfowl regulations one of the nation's more hazardous occupations. As a result, we now are able to contemplate this responsibility with a modicum of tranquility—that is to say of the same order of magnitude of that of the lion tamer, the test pilot, or the man who washes the windows of the Empire State building.

Even while the systems established for measuring waterfowl populations and determining the extent of maximum justified harvest were evolving, it had become apparent that management of birds with distinct habitat requirements would become an academic pastime if the habitat itself were to be dissipated.

Today, of course, there is a crushing awareness of this problem. Without habitat there is no waterfowl resource. Yet on every side, despite valiant efforts by conservationists and public administrators, destruction of habitat continues at an accelerated rate.

If this condition exists today with a human population of 180 million people, consider what it will be when there are 200 million and more crowding into what were once the haunts of the wild.

The draglines rip their furrows in the pothole landscape of the prairies. The dredges suck the essence from the coastal estuaries and spew destruction over the adjacent marshes. Wetlands overnight become garbage dumps and leaching fields for sewage disposal plants.

With our customary myopia, we here in the United States tend to think that destruction like this is our own phenomeon. Yet I am told that the destruction of waterfowl nesting habitat due to agricultural economic conditions has accelerated greatly in the recent years of relatively light rainfall in Canada, and that coastal marsh destruction is beginning to occur in Mexico. The problem is truly a continental one.

Most of you are aware that in this country, the principal effort to contain wetlands destruction has been that of the fish and game agencies, State and Federal, aided and abetted by State and national conservation organizations. For 24 years the Federal Government carried on its modest wetland acquisition with part of the funds derived from the sale of the duck stamp. In 1958, simultaneous with the increase in the price of the stamp from $2 to $3, all of the income was earmarked for acquisition. But it was not until the Congress approved the Accelerated Wetlands Acquisition program in 1961 that sufficient finances were poured into the solution of the problem to make a dent in the widespread destruction.

We are now just at the halfway point in this accelerated program. It is a primary purpose of my remarks to report to you the status of this work.

Our initial goals established an overall total of 12½ million acres in, or to be acquired and placed in public management for waterfowl conservation purposes. Of this amount, we had previously secured about 3½ million acres, with an additional 2 million in State ownership. We hoped that through the accelerated program we could acquire 4½ million and on their own, the States could buy the remaining 2½ million.

As of December 31, 1964, we had actually acquired 385,000 acres, 15 percent of the total Federal acreage goal. Of this figure, 145,000 acres were in waterfowl habitat placed in the Federal refuge system, and the remaining 240,000 acres, 190,000 acres of which were easements, were in the waterfowl production area program.

Money-wise, the picture is much the same. Appropriated funds advanced by the Congress total $25 million through June 30, 1965. Duck stamp receipts during the period July 1, 1961, to December 31, 1965, of this year were $15,435,117 for a total of $40,435,117 available currently from both sources. This is 35 percent of the $140 million we anticipated would be available. (Table 1.)

TABLE 1
DEPARTMENT OF THE INTERIOR
BUREAU OF SPORT FISHERIES AND WILDLIFE

SEVEN-YEAR ACCELERATED WATERFOWL LAND ACQUISITION PROGRAM
(Fiscal Years 1962–1968)

Fiscal Year	Acres Acquired or Contracted**				Cost
	Breeding	Migration	Wintering	Total	
		Atlantic Flyway			
1962	941	341	173	1,455	$ 203,541
1963	6,036	554	25,222	31,812	3,147,725
1964	4,444	2,435	13,856	20,735	2,378,346
1965*	820	81	5,285	6,186	363,042
Totals	12,241	3,411	44,536	60,188	$6,092,654
		Mississippi Flyway			
1962	2,510	1,324	4,037	7,871	1,152,908
1963	3,680	671	3,221	7,572	979,569
1964	22,548	4,584	9,316	36,448	3,902,584
1965*	11,080	317	1,013	12,410	906,865
Totals	39,818	6,896	17,587	64,301	$6,941,926
		Central Flyway			
1962	16,237	271	9,730	26,238	$1,320,909
1963	25,048	6,513	3,020	34,581	1,707,728
1964	80,040	4,326	85	84,451	1,843,582
1965*	85,283	—	—	85,283	1,276,753
Totals	206,608	11,110	12,835	230,553	$6,148,972
		Pacific Flyway			
1962	—	—	—	—	—
1963	5,603	—	9,012	14,615	$3,173,939
1964	5,224	—	1,361	6,585	1,033,658
1965*	3,640	—	646	4,286	765,432
Totals	14,467	—	11,019	25,486	$4,973,029
GRAND TOTAL	273,134	21,417	85,977	380,528	$24,156,581

*Through December 31, 1964.
** Includes easements to prohibit wetlands drainage.

This record is not one to instill a pleasant feeling of complacency. The program obviously is, or has been, in trouble, or the original goals were unrealistic. Let us analyze the situation.

While the funding record is materially short of that visualized in the original authorization, I do not believe it would be fair to say that restrictions in the amount of funds have been the primary obstacle. A more rapid expansion of the program, including both those of an intra and extra mural nature, could well have led to even more difficulties in program execution than we are experiencing at present.

We are having increasing success with the acquisition of easements on pothole areas to prevent their drainage. New and high rates of accomplishment are being attained. The record of the last six months of 1964 exceeds that of the previous three years. Now that this program has caught on, we believe that a good percentage of the remaining potholes can be saved.

Our biggest hurdle in the acquisition of any area is securing the essential public support at the local level. It is almost axiomatic that few landowners are really interested in selling their land. This is just as true of duck hunters who own a choice but vulnerable marsh as it is for a farmer or a city-employed rural resident. Spurred by the more vocal and violent opponents, even the conservation-oriented citizen withholds his support locally, with a predictable political furore as an almost inevitable accompaniment.

In the pothole country particularly, but elsewhere to some extent, this problem became so acute that statewide embargoes were placed on our acquisition efforts by the governors, who under the law must approve every project.

Generating local support for a wetlands purchase project which may disrupt the local economic, social, and political structure, particularly when the benefits may well be dispersed quite widely over a large fraction of the country, will continue to be a very real problem.

Even the passage of the refuge revenue sharing bill by the Congress will not remove all the local objections. Others will be formed or imagined.

We have been fortunate in having the Migratory Bird Conservation Commission as a vehicle for carrying these projects through the final approval stage. If every project were to go to Congress for authorization, obviously little would be accomplished, irrespective of the interest the Congress generally shows in conservation affairs. Nevertheless, we believe there may be ways not only to streamline our project documentation but also the approval process itself.

Essentially, what is needed most is a comprehensive and yet well-focused selling job. We must convince the many local interests that a refuge not only will not be a liability, but an asset to the community in future years. We know that the best advertising is good performance. That is one reason that our efforts to make people welcome at wildlife refuges is so important.

It is a double burden when we find we have to "sell" our conservation-oriented friends before we can even begin a project. We try to work with the States to insure complete integration of our efforts, but on occasion the political heat becomes unbearable and we lose the battle before a shot is fired.

In a few instances, we have failed to secure the support of the State fish and game administrator. Usually this results from fears of added Federal intrusion into State management affairs. Occasionally, questions of personalities or even minor grievances prevent reaching the needed accord. We propose to work with the States toward a reconciliation of policy matters pertaining to the administration of acquired areas.

Close working relations with the State fish and game agencies become doubly important as the States pick up momentum in their own acquisition efforts. We have recognized the need in States where bond issue purchase has been started, and have carefully integrated our efforts to assure realistic targets and prevent duplication which might result in two agencies, one State, one Federal, bidding against each other for the same piece of property. With the relatively large sums of money coming into land acquisition activities through the land and water conservation fund, refined coordination will be even more imperative.

Noting the resistance to the entrance of the Federal Government in wetlands acquisition early in the history of the accelerated program, we began explorations to determine by what means we could enlist the direct cooperation of the States in the purchase efforts. Suggestions that the authorizing legislation be amended to permit sharing the program with the States have been advanced from time to time. We are not in a position to comment specifically on these proposals, primarily because we have not been able to develop a feasible plan for an appropriate division of the funds. It is apparent, however, that any amendment designed to effect these modifications in approach would have to withstand a very critical examination by the Congress, and that the provision of Federal funds to the States through the land and water conservation fund would likely be viewed as a suitable alternative. We would expect, however, that if there is serious interest in this idea it will be given appropriate study by the International Association of Game, Fish and Conservation Commissioners. We, of course, would be pleased to be of such assistance as we could be in such a study.

This year we will dedicate a new waterfowl research station in the heart of the pothole region, the first of its kind in our agency. This Northern Prairie Wildlife Research Center will find ways to increase the carrying capacity of the available waterfowl habitat. But we must further expand the research effort. We hope that increased research will provide the same increase in the productivity and utility of our waterfowl resource that has resulted from agricultural research. It must if the dwindling habitat is to meet the needs of the future.

We must take advantage of every opportunity to promote the preservation, development and restoration of habitat on lands other than those in State or Federal ownership. Today, the opportunities for land use modification to benefit waterfowl are greater than at any time in history. The entire weight of the U. S. Department of Agriculture is being directed toward diversion of agricultural land for recreation and conservation uses. It is the time for the Department of Agriculture and wildlife agencies to become real working partners in wetlands preservation and devlopment.

A joint effort should be made to show individual landowners that there are many incentives which provide an economic alternative to wetland drainage. Such incentives include our own wetland easement payments, Agriculture's ACP payments, economic assistance from State conservation departments, financial assistance from sportsman clubs, compensation for wildlife production in the way of hunting leases, hunter use fees or charges for landowner's services to hunters.

In order to promote recognition of such benefits, we have established a Division of Wildlife Services within our Bureau. This Division will work with other conservation agencies to develop the means for providing technical wildlife information, direction, and on-the-ground services to any group or individual requesting or receptive to it, either public or private.

There are wetland areas held by public agencies that can be more fully developed for waterfowl. To illustrate, we recently assisted the Bureau of Indian Affairs in developing 4,000 acres of prime waterfowl habitat in conjunction with the establishment of a wild rice industry on Red Lake Indian Reservation in northern Minnesota. The cost was small, but the benefits to waterfowl will be great.

There is increased need to work with our cities in their open space programs. Many of them can preserve valuable waterfowl habitat. Other areas can be developed for waterfowl. Although many of the areas are small, they can provide a maximum conservation education opportunity.

Many organized conservation and sportsmen's clubs need active constructive projects. Demonstration units can show how marsh restoration can become a club project. We need to help these clubs develop optimum habitat on their lands.

A high degree of water resource development will be required in most river basins throughout the country to meet future water needs. Therefore, we will continue to study water development projects with a view to prevent damage to waterfowl habitat, incorporating measures to mitigate losses and to take advantage of opportunities to create new habitat.

Some items affecting habitat preservation are purely State problems. I know, for example, that Minnesota is attempting to revise many of its present drainage laws. This is good and needs to be done. If we can help, we will.

Are we taking full advantage of the laws that are in existence? In this respect, I understand that in some areas of North Dakota, before any wetland with a watershed of more than 80 acres can be drained, approval must be obtained from the State Water Commission. If these restrictions are not being honored or enforced, we are failing.

Frequently proposed residential, or industrial development projects on coastal marshes can be headed off by strict enforcement of zoning or building restrictions. Massachusetts and Rhode Island are leading a movement for formation of Town Conservation Commissions. These local governmental groups are laying local conservation issues before the public; organizing support for good resources management. This is the sort of local action needed to preserve waterfowl habitat.

Certainly students, naturalists, bird watchers, photographers, hunters, and many others benefit from wetlands. They have and will continue to rally to the support of wetland preservation. However, we must sell farmers, landowners, and the public at large on the importance of a program of habitat preservation, restoration, and development.

In summary, acquisition is only a partial solution to the crisis in waterfowl habitat. Part lies in a solution to the broad farm production problems and artificial values on surpluses. Somewhere in this solution national wildlife values must be translated into tangible benefits to farmers competitive with other crop production. Part lies in research and a broader base of public interest and effort. Finally, a part may lie in some kind of zoning of remaining land and water areas in densely or potentially densely populated coastal regions whereby all national values get equitable recognition.

Perhaps we may be guilty of believing what we want to see, rather than what actually exists, but we believe that we have been experiencing the growing pains of any large-scale public effort. We think we have solved several of our severe problems. The fact remains, however, that there are many more yet to be solved, and to use the timeworn phrase "things may well get worse before they get better."

DISCUSSION

VICE CHAIRMAN ANDERSON: Well, we seem to have a Federal wildlife administrator who thinks that if leadership is expected of him that he might as well start leading the pack. I am sure he has shown appropriate concern for the maintenance of waterfowl habitat, and we also have heard today that Canada and Mexico are also equally concerned.

I am also sure that Director Gottschalk realizes that if these waterfowl regulations get too strict or too complicated that there is danger in the fact that the sportsmen will lose interest and, of course, this in turn, will mean a loss of support for waterfowl habitat maintenance. On the other hand, I trust the he is equally aware that you can run out of ducks in order merely to maintain interest and habitat.

I think it behooves all of us here today to remind the sportsmen that when the going gets tough, as it has been and still is, if they really love their sport, as they claim to do, then in such times they will redouble their efforts for organizations such as Ducks Unlimited, and realize that basically the wildlife administrator is there to perpetuate their sport.

John, you mentioned that the Land and Water Conservation Fund could make considerable more money available, possibly a lot more money than has been available through duck stamps. It is my hope you will be able to spend considerable portions of it actually for waterfowl management. It seems to me that there is a very real danger that the Bureau of Outdoor Recreation, with what they say is perhaps 25 times as much money available as we have had, can, instead of maintaining wildlife habitat, produce millions and millions of picnic grounds, horseshoe courts, camping areas complete with flush toilets and that, as a result, real wildlife values will be lost.

I think that unless we are very watchful BOR could be one of the greatest threats of waterfowl conservation progress we have and more so than the Department of Agriculture ever was.

Now, does anybody have any questions to direct at Mr. Gottschalk who has the simple job of trying to keep two or three million hunters satisfied?

MR. JAMES SHEPARD (Massachusetts): I don't have a question but I would like to congratulate Director Gottschalk for his comments on the consideration of direct participation by state fish and game agencies in this wetlands preservation program. I just feel that this may serve as the impetus for seeing that the program rolls along at a rate somewhat greater than the rate that it is moving today.

MR. LAURENCE JAHN (Wisconsin): We heard today of the realistic approach being used to provide incentives to landowners to maintain wetlands, especially for duck habitat. In the new extension unit being established within the Bureau, is this healthy attitude also going to be expressed? In other words, I hope you don't get lost among the flush toilets and the new money that becomes available and lose sight of the fact that very small wetlands gathered in private lands are the most important thing.

MR. GOTTSCHALK: The way you phrased the original part of the question I would almost have to say I never did beat my wife. However, my answer to your question is, "Yes," we are going to become concerned about those small wetlands and, "No," we are not going to let these become lost in this great big welter. The only thing I can say is that I have a real conviction that there is as much to be gained from small wetland preservation across the country as there is from the acquisition of large areas that we have gotten mixed up in over the past 20 years. I think our program is going to have to be retained, even that part of it which comes under the Migratory Bird Conservation Act. This does involve wetland areas.

There is as much to be gained from the preservation of small areas taken across the country as any other facet of the program.

I would hope that we will see some thought given not only to the possibility of state participation in this duck stamp revenue, for example, but I think it would be equally advantageous to push down to the town level.

The work that Massachusetts, Rhode Island and Connecticut have been doing with their conservation commission, stimulating interest in ponds of five acres, twenty acres or fifty acres, in the long run will be tremendously significant. We want to do everything we can to augment that effort in order to make it more fruitful. We are going to do everything we can, working with these local groups in cooperation with other people who have capabilities in this field, to try to make the preservation of small areas something really of national significance when you add it all up.

MR. FRANK DUGAN: I have spent approximately half of my career with the Agricultural Extension Service. I merely want to congratulate Director Gottschalk on his announcement that the Fish and Wildlife Service is finally going to do exactly what the biologists of the Agricultural Extension Service and Soil Conservation Service have been doing for 30 years.

CHAIRMAN MARSHALL: If there are no further questions or comments, I would like to close this session by thanking the members who have presented papers and who have discussed these problems with us and also by thanking John Anderson for his usual sharp comments and questions and pointing out to us, as I did at the beginning of this session, that the major intent was to place focus on the broader aspects of waterfowl conservation which is, indeed, all that these people have done.

TECHNICAL SESSION

Tuesday Morning—March 9

Chairman: JOHN W. MCKEAN
Chief, Game Division, Oregon State Game Commission, Portland

Discussion Leader: HENRY S. MOSBY
Professor, Department of Forestry and Wildlife, Virginia Polytechnic Institute, Blacksburg

FOREST AND RANGE RESOURCES

DEER NUTRITION RESEARCH IN RANGE MANAGEMENT

DONALD R. DIETZ[1]

Forest Service, U. S. Department of Agriculture, Rocky Mountain Forest and Range Experiment Station[2] Rapid City, South Dakota

Wildlife management in future years will undoubtedly undergo decided changes. Competition for land use will intensify as the demands for space for our growing human population multiply. The game-range manager will, of necessity, practice more intensive management on less land area. To meet this coming challenge, those responsible for management of our wild lands will need to rely heavily upon improved methods for measuring animal populations and assessing habitat factors. It is essential that we know the quality as well as the quantity of forage produced on various habitat types, and understand the factors that affect these nutritional attributes.

Although wildlife nutrition is not a new field, published results are scarce and often fragmentary. Also, many game managers do not have a background in wildlife nutrition and thus are limited in their ability to apply available nutritional data to their particular problems. To help the wildlife manager use nutritional information as

[1] Wildlife Research Biologist.
[2] Central headquarters maintained in cooperation with Colorado State University at Fort Collins, Colorado. Author stationed at Rapid City, South Dakota in cooperation with South Dakota School of Mines and Technology.

an effective tool, this paper describes the importance and usefulness of some nutritional measurements and discusses the results of some nutritional studies on big-game range in Colorado.

DESCRIPTION AND IMPORTANCE OF NUTRITIONAL MEASUREMENTS

Most technical papers concerning wildlife nutrition assume the readers are familiar with the specialized vocabulary used. Since most wildlife managers are not nutritionists, let us review some of the frequently used terms and examine their importance.

Chemical Analysis Systems

There are several ways or schemes for separating plant material into various nutritive components. In this section some of these methods are presented and discussed.

Proximate Analysis.—This system was introduced prior to the beginning of the 20th century and is still in common use today. It involves the determination of crude protein, crude fat (ether extract), crude fiber, and ash by chemical tests, and an estimation of nitrogen-free extract by subtracting the percentages of the other components from 100. The most obvious shortcoming of the proximate scheme is that crude fiber and nitrogen-free extract are not precise chemical groups, and do not actually separate carbohydrates into digestible and indigestible portions (Richards and Reid, 1953).

Other Analysis Schemes.—Many studies concerning the nutritional content of plants also present some data on mineral composition—usually, at least, percentages of calcium and phosphorus. Instead of crude fiber and nitrogen-free extract, some authors list percentages of individual carbohydrate components including cellulose, hemicelluloses, starch, reducing and total sugars, and lignin.

Chemical Constituents and Their Importance

Crude Protein.—This represents protein and nonprotein nitrogen. It is calculated by multiplying the nitrogen percentage of feed by a factor, usually 6.25. This does not give an indication of the kinds and amounts of amino acids present, but there is no evidence that ruminant animals require certain amino acids in forage since digestion in the rumen is a microbiological process and amino acids are synthesized as needed (Sullivan, 1962).

Animals must have protein to form new cells essential for body maintenance, growth, reproduction, and lactation. The ruminant animal needs protein for the rumen micro-organisms to effectively digest and metabolize carbohydrates and fats. If protein levels fall below a minimal level, thought to be around 6-7 percent, rumen function becomes severely impaired. Very high protein levels are not only unnecessary, but inefficient for ruminant animals. Based on studies with sheep, the National Academy of Sciences-National Research Council (1957) recommends protein levels of approximately 7 to 11 percent, the younger and smaller animals requiring the higher amounts. French *et al.* (1955) have suggested a diet containing 13 to 16 percent protein for optimum growth of white-tailed deer.

Crude Fat.—This portion includes all of the various plant substances soluble in ether. True fat provides 2.25 times more energy than carbohydrates and proteins, but less than half of ether extract in plants may be true fat (Sullivan, 1962). Shrubs may contain considerable quantities of "essential oils" which have no feeding value. These oils are not really essential, but get their name because of the substances found in the essences or volatile compounds which give many plants their characteristic odor or taste.

Plants such as big sagebrush (*Artemisia tridentata*) contain large amounts of essential oils that are not only indigestible, but are harmful to rumen micro-organisms and impair rumen function (Nagy *et al.*, 1964).

Although ruminants are not dependent upon fat, which can be synthesized in the rumen from carbohydrates and proteins, it does provide an efficient source of energy.

Carbohydrates.—The bulk of the plant material eaten by game animals consists of some form of carbohydrate. Nitrogen-free extract represents the more digestible portion, while crude fiber represents the more indigestible portions. Lignin, not a true carbohydrate, is a better indicator of the indigestible portion than crude fiber. Micro-organisms in the rumen break down the carbohydrate constituents and produce volatile fatty acids that provide most of the energy needed by the animal (Annison and Lewis, 1959).

In general, if a game range produces enough palatable forage for the game population to eat a sufficient amount, there should be no carbohydrate deficiencies.

Calcium.—The game animal must have access to adequate calcium supplies. Calcium plays an important part in skeletal development and is an important component of blood. On western game-ranges calcium supplies are usually ample, and in fact may be high enough to adversely affect the metabolism of phosphorus.

Phosphorus.—This mineral is vital in many body processes. It is an essential part of the skeleton, intracellular fluid, and compounds such as nucleoproteins and phospholipids. Phosphorus is necessary in the production of muscle energy through the action of adenosine triphosphate (ATP), which contains high-energy phosphate bonds. A deficiency of phosphorus or a wide calcium-phosphorus ratio could cause retarded growth, a high feed requirement, unthrifty appearance, weak young, decreased lactation, failure to conceive, stiffness of joints, and many other abnormalities. A desirable calcium-phosphorus ratio is somewhere between 1 to 2 and 2 to 1, but wider ratios are permissible if sufficient vitamin D is present in the ration (Maynard and Loosli, 1956).

Phosphorus is reportedly deficient in many forage species on western game ranges during the winter season. This may be an important factor in low fawn production on many of these ranges. It points out the need to manage winter ranges for those species which maintain adequate phosphorus levels. Minimum recommended phosphorus levels for deer on shrub ranges have not been worked out, although French *et al.* (1955) gave a figure of 0.25 percent for white-tailed deer in Pennsylvania. The National Academy of Sciences-National Research Council (1957) reported forage for pregnant ewes should contain at least 0.16 percent phosphorus. Many shrubs and most grasses do not maintain this high a level of phosphorus on western deer ranges in the fall and winter; therefore, deer herds are dependent on shrubs that do.

Energy.—With the possible exception of protein and phosphorus deficiencies, the most common nutritional deficiency of deer is lack of either available energy, digestible energy, or both. This is also true for sheep as observed by the National Academy of Sciences-National Research Council (1957), who reported that low-quality roughage, even if present in abundance, will not supply enough total digestible nutrients (TDN) to satisfy dietary demands. They also observed that energy shortages may be due to not enough feed, snow covering feed, or because of a low dry matter content of lush, watery feeds. This shortage of energy-producing feed is most common on overbrowsed deer winter ranges and on early spring ranges at the time deer switch to lush green grass and forbs. Thus a poor winter range will adversely affect a deer herd in several ways: it will not provide enough forage to supply needed energy supplies; it will not supply enough protein and phosphorus for the animal to make efficient use of the available energy; it will cause a cessation of growth, loss of weight, reproductive failure, and impaired rumen function; and it will cause the animals to switch to watery green forage of low dry matter content as soon as it appears in the spring. This frequently results in scours or inability of the weakened animal to adjust to the new feed, and heavy mortality may result.

Gross energy is defined as calories per gram of feed. Digestible energy (DE), the calories apparently digested or retained by the animal, is calculated by subtracting the calories lost in feces from that contained in the feed. Metabolizable energy (ME) is digestible energy minus the energy lost in urine and methane production. Net energy (NE) of feed is calculated as the gross energy minus the energy lost in feces, urine, methane, and in the production of heat (Harris *et al.*, 1959).

The measurement of total digestible nutrients has been used most frequently in range energy investigations. It is based on the digestibility of the proximate principals: protein, fat, fiber, nitrogen-free extract, and ash. It attempts to provide information on feed energy through giving fat 2.25 times the weight or energy value of the other components. TDN is closely related to digestible energy, but is less accurate in estimating energy values. Both TDN and digestible energy techniques have been criticized by Harris *et al.* (1959) for use on shrub ranges since high essential oil percentages in some of the plants give erroneously high TDN or DE values. These authors recommended using metabolizable energy values for range studies. If methane values must be calculated rather than measured directly, however, some degree of error will be introduced. Evaluation of feed for ruminants is not clear-cut, but does yield information useful in game-range management.

A SUMMARY OF SOME DEER NUTRITIONAL STUDIES

In the following sections, highlights of several deer nutritional studies conducted by the author and various co-workers are presented as they relate to game-range management. Readers are referred to the original publications for detailed accounts of materials, experimental designs, statistical analyses, and tabular results. The results of these studies are given under major factors investigated which affect the nutritive value of forages.

Factors That Affect Plant Nutritive Content

Clipping Intensity.—In a study in southwestern Colorado, five browse species were subjected to light (20 percent) and heavy (80 percent) clipping treatments annually over a 7-year period. The current annual growth of each clipping treatment for the first and last years of the experiment were chemically analyzed. No significant differences in the protein, ash, calcium, and phosphorus percentages of the samples were found between clipping treatments.

The most important conclusion from this study was that prolonged, heavy browsing of shrubs by game and livestock probably would not affect their nutritive content, although of course it might adversely affect other plant attributes, such as production, growth form, and longevity (Dietz, 1957).

Seasonal Progression.—The levels of individual nutrients in forage plants eaten by deer vary markedly with season. Important shrub and grass species from the Mesa Verde region of southwestern Colorado and the Cache la Poudre Canyon area of north-central Colorado exhibited the following seasonal trends in nutritive content: (1) Plants were generally highest in protein, carotene, ash, calcium, and phosphorus in early summer and then decreased in nutritive content until early spring when winter buds enlarged. (2) Crude fat, fiber, and nitrogen-free extract percentages generally increased in the plants as phenology advanced toward winter dormancy.

It is quite evident from the nutritive differences in plants during seasonal progression that game-ranges are not static, but provide game animals with a constantly changing diet. In general, the succulent forage available during late spring and early summer provides nutrients needed for growth, fawning, lactation, antler development, and body tone. As the plant growth matures in the late summer and early fall, fat and carbohydrates increase and the diet changes from a growing ration to a fattening ration. During midwinter, plants are dormant and supply only a maintenance ration (Dietz, 1958; Dietz *et al.*, 1958, 1962).

Plant Part.—The current annual growth of four deciduous shrubs collected in the Mesa Verde National Park region was separated into leaf and stem components for nutritive analysis. Two of the plants, Gambel oak (*Quercus gambeli*) and serviceberry (*Amelanchier alnifolia*), were preferred summer and fall foods of mule deer, while bitterbrush (*Purshia tridentata*) and mountainmahogany (*Cercocarpus montanus*) were used more intensively during fall and winter.

The leaves of the four browse species contained considerably higher percentages of protein, phosphorus, and carotene, and slightly higher percentages of fat, nitrogen-free extract, ash, and calcium than the stems during late spring. The stems contained more crude fiber during these periods. While leaves contained their highest percentages of important nutrients during the growing period of late spring and early summer, the stems contained their highest levels during the period of bud enlargement in late winter.

Not only are leaves higher in nutritive value, they also contribute most of the total yearly production. The leaves of the preferred summer browses far exceeded the stems in total weight of material produced. It is evident that deer not only have more total forage to select from during the summer growth period, but also nutritionally superior feed as compared to winter stems (Dietz, 1958).

Plant Species.—Studies in Mesa Verde National Park, and on high-elevation summer range (above 9,000 feet), high-elevation winter range (8,000 feet), and low-elevation winter range (below 7,000 feet) in the Cache la Poudre Canyon area of Colorado have disclosed marked differences in the nutritive content of the species of plants eaten by deer. In general it was found that summer range plants were more nutritious than high winter range plants, and that high winter range plants were nutritionally superior to low winter range plants.

Aspen (*Populus tremuloides*) and willow (*Salix subcoerulea*) collected during late spring from summer range contained over 20 percent protein, and provided the best source of this nutrient during the summer period. Another good source of protein during summer was tufted hairgrass (*Deschampsia caespitosa*).

All of the winter range shrubs tested on the Cache la Poudre range contained adequate amounts of crude protein during the critical winter season. Big sagebrush and rabbitbrush (*Chrysothamnus nauseous*) were the best providers of protein during winter, generally maintaining levels of 10 percent or higher. On summer range, only willow maintained a relatively high protein level during the fall period.

Phosphorus levels are probably second in importance to protein on western deer ranges. Willow and aspen were the best sources of phosphorus in the late spring period, and big sagebrush, juniper (*Juniperus scopulorum*), and rabbitbrush were good sources of this mineral during the winter periods. If the 0.16 percent minimum level recommended by the National Academy of Sciences-National Research Council (1957) for phosphorus applies to forage for deer, then mountainmahogany, bitterbrush, aspen, and tufted hairgrass were deficient during the fall and winter periods.

Aspen, big sagebrush, juniper, and rabbitbrush were good sources of crude fat, especially in the fall; tufted hairgrass, blueberry (*Vaccinium scoparium*), mountainmahogany, and Gambel oak were poor sources of fat at all seasons.

Crude fiber is inversely correlated with digestibility, and therefore is a fair indicator of forage quality. Mountainmahogany, Gambel oak, bitterbrush, rabbitbrush, blueberry, and tufted hairgrass contained high percentages of crude fiber during the dormant season, while aspen, willow, big sagebrush, and juniper contained considerably lesser amounts at this period and were probably more digestible.

A large number of palatable forage species on a deer range will provide a more balanced diet and give the animals an opportunity to select the more nutritious species and plant parts. On overbrowsed winter range, the animals may be forced to consume such low-quality forage that malnutrition may result. Evergreen and semievergreen species, such as juniper, big sagebrush, rabbitbrush and bitterbrush, are important on winter ranges because they generally maintain higher nutritive levels than the deciduous shrubs, forbs, and grasses (Dietz, 1958; Dietz *et al.*, 1962).

Other Factors.—Mountainmahogany samples collected from high winter range were nutritionally superior to similar material from low winter range (Dietz *et al.*, 1962). In this case the greater amounts of moisture received at the higher elevations probably accounted for the difference.

Significant differences between year of collection were observed in mean crude fiber, nitrogen-free extract, and calcium percentages of shrubs on the Cache la Poudre winter range, and in mean crude fat, crude fiber, and calcium percentages on nearby summer range (Dietz *et al.*, 1962). Factors that might cause such differences are weather and experimental error induced by sampling differences.

Digestibility of Nutrients in Browse by Deer

Three of the most important browse species on Colorado winter deer ranges—big sagebrush, bitterbrush, and mountainmahogany—were fed to four mule deer fawns both alone and in combination with alfalfa pellets. Sagebrush nutrients had higher digestion coefficients, more total digestible nutrients (TDN), and a narrower nutritive ratio (NR) than bitterbrush and mountainmahogany as determined by difference with alfalfa pellets. Mountainmahogany had higher digestion coefficients for protein, fat, and crude fiber than did bitterbrush in both single-feed and by difference trials.

Addition of alfalfa pellets to the browse ration lowered the digestibility of individual nutrients and gave decidedly lower TDN values. This indicated that browse species were more digestible when fed alone than in mixtures, although the ration probably would not be as well balanced. The four mule deer fawns used in the digestibility trials showed no significant differences in their ability to digest the individual nutrients in the shrubs and alfalfa material fed to them.

In using nutritive digestion coefficients and TDN to estimate the carrying capacity of a deer range, the material analyzed should contain a mixture of forage species in the proportion they are normally ingested. This will give a more accurate and representative idea of the quality of range at that period (Dietz *et al.*, 1962).

MANAGEMENT APPLICATIONS

The quality of forage for game is determined by (1) the levels of important nutrients contained in the portion eaten, (2) the ability of game animals to digest these nutrients, and (3) the efficiency of the digested nutrients to meet the physiological demands of the body for maintenance, growth, reproduction, fattening, and other processes and activities. It must be remembered that, in assessing forage quality for ranges primarily used by ruminant animals, the end results are measured by animal performance; this performance will be determined largely by the ability of the rumen micro-organisms to use the nutrients in the ingested feed efficiently.

Principles of animal nutrition learned from domestic livestock also apply to wildlife, but generally wild animals must depend more on wild plants, and cannot be moved to more nutritious ranges.

The game-range manager can use nutritional information to manage his game herds more effectively. Important questions which nutritional studies may answer are:

1. Which game ranges are of high nutritional quality, and which are deficient? Answers will provide a guide as to where to place management emphasis.
2. What range improvement measures may be needed to round out nutritional requirements on different ranges?
3. Which plants contain high levels of various nutrients at each season? These plants can be favored in the management of game habitat.

This type of information will help the manager interpret conditions on a game range, and give him an idea of the general health and well-being of the game animals that inhabit it.

The nutritional levels of staple forages should be determined during periods when they are being utilized. This can be done in conjunction with forage production estimates if clipped weights are being obtained. The nutrients most important to measure are probably dry matter, crude protein, lignin or crude fiber, ash, and phosphorus. Gross energy figures are valuable if digestible or metabolizable energy can also be determined.

If the nutritional studies show the forage on the game range to be deficient in certain nutrients or in total energy, improvement practices can be initiated. Prescribed burning, which increases sprouting of some tree and browse species (Lay, 1957), has reportedly resulted in temporary increases in nutritional value of shrub ranges. Fertilizing and planting shrubs and food patches are other ways of providing nutritious forage on critically needed big-game ranges (Brown and Mandery, 1962).

Nutritional information has been used by game-range managers (1) to compare plants on the range by the levels of nutrients they maintain during periods of deer use, (2) as a partial basis for selecting which plant species to encourage in their propagation and revegetation and upon which to base management plans, (3) as a basis for selecting the most valuable type of winter range for lease or purchase, (4) to estimate game and livestock grazing capacities to use in adjusting stocking rates, and (5) to estimate monetary and other values of rangelands for compensation upon loss for other uses such as dams and industrial sites or housing developments.

SUMMARY

The game-range manager will need to practice more intensive management on less land area in future years as competition for land increases. To meet this challenge he will need to have a better understanding of the nutritional aspects of game habitats on his management areas. This paper describes various nutritional measurements and discusses their usefulness as they relate to game-range management.

Several nutritional studies on deer ranges in Colorado are summarized. Important findings include the following: (1) Clipping intensity did not affect nutritional value of plants. (2) Plants were generally higher in nutrients during the growing season than during the dormant season. (3) The leaves of plants contained higher percentages of nutrients than the stems. (4) Summer range plants were generally more nutritious than winter range plants. (5) Browse species were more completely digested by deer when fed alone than in mixtures. (6) There were no significant differences among experimental deer in their ability to digest the nutrients of browse species.

Uses of nutritional data are proposed and discussed, and some methods of increasing nutritional levels in range forages are suggested.

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DISCUSSION

DISCUSSION LEADER MOSBY: The subject under discussion indicates we are now getting down to some of the basic requirements of the species we are attempting to manage.

DR. HALL (Texas): What is your explanation for the fact that you found slightly higher food protein content in the winter than you did in the summer?

MR. DIETZ: Actually we didn't have higher protein content in the total plant. It was just in the stems. My idea is that, as the leaves fall off, the nutrients are concentrated in the stem. And also, as winter buds form, a rise in protein and phosphorus begins toward the end of the winter season.

I think most of the nutrients are concentrated in the leaves in summer but, as the summer goes on, they switch to the stems which retain most of them over winter.

DR. DAVID KLEIN (Alaska Wildlife Research Unit): You mentioned the 6 to 7 percent protein level as the generally acceptable minimum for deer. Is this on a year-around basis? In our work in Alaska we found that deer with less than 15 percent protein content in summer diets didn't seem to measure up physically to those that were on over 15 percent, or in the neighborhood of 20 percent, in protein content.

MR. DIETZ: That is a good point. No, I meant winter maintenance. This has been worked out mostly for livestock with some work on deer. It is relative to the activity of the deer. In the fawning or gestation period, this should go considerably higher. I think for sheep the recommendation is 14 to 16 percent during that time, particularly when they are carrying lambs and right after it, into lactation. Of course, the quality of that protein may be important, too.

MR. MAURICE SULLIVAN (National Park Service): Here in the East, deer will sometimes eat dead and fallen leaves in October and November. You find this even when good living stems and buds are available. Did you analize that or do you have any idea why they do that?

MR. DIETZ: I made some analyses of ether extract in aspen leaves that had turned yellow and fallen, and it was extremely high, up about 10 percent. Now, I don't know the quality of the fat in aspen, but I suspect that it is probably a pretty good source. True fat, of course, has about two and a half times the energy of protein or carbohydrate. Crude fat may contain essential oils which are not actually metabolized by deer. However, I think a lot of leaves, when the colors change, still have good fat content.

DISCUSSION LEADER MOSBY: All these questions, indicate that we are now getting to the basic requirements of the species we manage.

We, too, have noticed that deer frequently will eat what appeared to be completely dried leaves and we are now proposing in Virginia an investigation similar to this to try to determine the nutrient qualities of dead leaves.

BRUSH MANAGEMENT TECHNIQUES FOR IMPROVED FORAGE VALUES IN SOUTH TEXAS[1]

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Most of the rangeland in the western United States is covered by low-growing woody plants. To some, these are browse plants and valuable for forage. To others they are woody weeds—brush plants, robbers of the valuable water that is in such short supply. While the woody browse plants are to be protected and managed, there is a constant battle to control the unwanted brush.

Effective brush control has been called the number one problem facing ranchers in Texas (USDA, 1964). Indeed the same can be said for the whole West. There is hardly a section in the western United States that does not need some brush control if maximum returns from domestic livestock are to be obtained. This need to reduce brush and improve grass production has led to an evolution of ideas involving brush control.

[1]This paper is contribution number 97, Rob and Bessie Welder Wildlife Foundation, Sinton, Texas.

Only a few years ago brush eradication was advocated. As it became evident that it was not feasible to eradicate a brush species, the concept gradually changed to one of controlling or reducing the brush population to a level where it offered a minimum of competition for grass. Much emotional discussion has been devoted to the topic of brush control and its effect on wildlife habitat, but little attention has been given to increasing the forage value of the brush itself. This paper reports data that show possibilities for brush management techniques that will actually increase the value of brush for forage. In other words, it may be possible to change an unwanted brush plant to a useful browse plant.

South Texas ranges offer unique possibilities for studying management techniques for increasing brush forage values. Much of the area is covered with a chaparral complex of 10 or more woody plants (Box, 1961). Most are relatively unpalatable and are of little value for forage. In addition, some are resistant to most brush control techniques. Attempted brush control methods are usually followed by a change in brush composition, and a density equal to the original stand often occurs in 10 to 15 years after treatment (Box, 1964).

METHODS AND PROCEDURES

During the summer of 1963, 20-acre plots of five commonly used mechanical control practices were established as randomized blocks on Miguel fine sandy loam and Victoria clay on the Welder Wildlife Foundation. Treatments on the Victoria clay included mowing, roller chopping, scalping with a K-G blade, root-plowing, and root-plowing and raking. Treatments on the Miguel fine sandy loam were identical with those on the clay soils except mowing was omitted because of the size of the brush.

Mowing consisted of shredding the brush with a rotary mower pulled behind a farm tractor. Treatment was limited to trees with diameters less than 3 inches. The mower pulverized the tops and spread the plant fragments over the soil. The remaining stumps were usually less than 3 inches in height.

The rolling chopper was a custom machine made from a large steel drum with blades welded onto the drum. The drum was filled with sand and pulled behind a crawler tractor. The brush tops were chopped into 12-14 inch sections and left on the soil.

Scalping was done with a commercially manufactured Rome K-G blade mounted on the front of a crawler tractor. The K-G blade is a large knife that attaches to the bottom of a bulldozer blade. The blade was set at a slight angle and held as close to the soil surface as possible, resulting in a shearing of the woody plants near or slightly below the soil surface. The brush was piled with a brush rake and the piles burned.

The root-plowing treatment consisted of a standard commercial root blade drawn behind a crawler tractor. The blade was held approximately 8 to 12 inches below the soil surface. The brush and roots were allowed to remain as they fell behind the plow.

The root-plow and rake treatment included root plowing as described above plus raking the plant material with a large root rake. The brush was piled and burned.

All brush treatments and the check plot were sampled with 15 randomly located 100-foot line intercepts per treatment during the summer of 1964. Canopy coverage of each species was recorded along the line, and brush density and percentage composition were calculated from the data.

The area was grazed continuously with Hereford steers at the rate of one animal unit to each 14 acres plus white-tailed deer at the rate of one deer to each 8 acres.

Browse utilization and frequency of use were measured on 25 randomly located plants of each of the woody species on each brush treatment in June, 1964. Preference values were calculated for each species by multiplying the percent utilization times the frequency of use as described by Dwyer (1961).

A "Forage Value" for each species was determined by multiplying the preference value of the forage by its density.

RESULTS

Change in density

All brush control treatments reduced the density of the brush species. One year after treatment almost half, 48.4%, of the check plot on Victoria clay was covered with brush. The mowed area had a brush cover of 18.2%, the chopped area 19.93%, the scalped area 18.4%, the root-plowed area 10.2% and the root-plowed and raked area 1.7% (Table 1). The woody vegetation on the Miguel fine sandy loam responded in a similar fashion. There the check plot had 45.2% brush cover, the chopped area 20.0%, the scalped area 16.9%, the root-plowed area 1.8%, and the root-plowed and raked area 2.1%.

TABLE 1. PERCENT GROUND COVER OF ALL BRUSH ON TREATED PLOTS ONE YEAR FOLLOWING TREATMENT

	Check	Mowed	Roller Chop	K-G Blade	Root Plow	Root-Plow & Rake
Victoria clay	48.4	18.2	19.9	18.4	10.2	1.7
Miguel FSL	45.2	——	20.4	16.9	1.8	2.1

The top growth removal treatments of mowing, chopping, and scalping had approximately 50% as much brush as the original cover the year following treatment. However, height of the plants on the treated area was only about a third that of the untreated area. All brush plants on the treated areas were within easy reach of deer and cattle; brush plants on untreated areas were largely unavailable due to the height and dense growth patterns of the chaparral mottes.

As in other studies, differential mortality occurred between brush species on the plowed areas on the sandy soils and on the clay soils (Box, 1964). The highest kill occurred on the sandy soils. There densities of only 1.8 and 2.1% occurred after treatment on root-plowed and root-plowed and raked areas respectively.

Root-plowing on the Victoria clay reduced brush density by about three-fourths while root-plowing and raking gave kills comparable to the treatments on sandy soil.

On both sites, cactus density increased greatly on the root-plowed areas. Tasajillo (*Opuntia leptocaulis DC.*) increased 720% on the root-plowed Victoria clay and 50% on the sandy loam. Pricklypear (*Opuntia lindheimeri* Engelm.) increased 160% on root-plowed Victoria clay and remained the same on sandy soils. There was no significant increase in cactus density on the root-plowed and raked areas.

Change in species composition

Each species responded differently to the brush management treatments. Generally, the top removal techniques caused vigorous resprouting of most brush species, resulting in dense, low stands of the same brush species that were removed. For instance, on clay soils, only mesquite (*Prosopis glandulosa* Torr.), pricklypear (*Opuntia lindheimeri* Engelm.) and tasajillo (*Opuntia leptocaulis* DC.) decreased in relative abundance following treatment (Table 2). Huisache (*Acacia farnesiana* [L.] Willd.), blackbrush (*Acacia rigidula* Benth.), agarito (*Berberis trifoliolata* Moric.), granjeno (*Celtis pallida* Torr.), lote (*Condalia obtusifolia* [Hook] (Weber.), brazil (*Condalia obovata* Hook.), Mexican persimmon (*Diospyros texana* Scheele), and prickly ash (*Zanthoxylum fagara* [L.] Sarg.) all increased in relative abundance over the check plots.

Mesquite was also reduced in relative abundance by the top removal treatments on the sandy soils. However, the rapid increase in the percentage composition of other plants was observable in only four species: blackbrush, chittimwood (*Bumelia lanuginosa* [Michx.] Pers.), live oak (*Quercus virginiana* Miel.), and prickly ash (*Zanthoxylum fagara* [L.] Sarg.) (Table 2).

TABLE 2. PERCENT COMPOSITION OF WOODY PLANTS ON BRUSH CONTROL PLOTS, 1964

	Check		Roller Chop		K-G Blade		Root Plow		Root Plow & Rake		Mowed
	Clay	FSL	Clay	FSL	Clay	FSL	Clay	FSL	Clay	FSL	Clay
Acacia farnesiana	4.1	7.4	20.1	2.5	10.8	7.9	3.2	T	25.6	T	17.4
Acacia rigidula	2.4	2.9	11.2	6.4	16.3	7.5	T	8.9	T	T	2.9
Acacia tortuosa	0.6	3.4	T	3.3	T	3.3	T	—	T	T	T
Berberis trifoliolata	3.7	1.0	12.3	T	5.3	T	T	2.2	T	T	1.9
Bumelia lanuginosa	—	1.2	—	10.2	—	7.7	T	—	T	—	—
Celtis pallida	1.8	5.1	5.6	5.8	10.6	4.8	T	1.0	T	25.0	4.4
Celtis sp.	—		—	2.8	—	.7	—	—	—		—
Condalia obtusifolia	2.5	4.2	3.6	1.3	5.3	T	T	—	5.0	T	5.0
Condalia obovata	0.4	3.5	3.0	4.1	5.3	.2	T	—	T	T	3.5
Diospyros texana	0.4	10.4	2.1	11.0	0.7	9.7	T	—	T	—	2.3
Lycium sp.	1.0	—	1.0	1.6	3.5	.4	1.6	—	12.8	—	1.0
Opuntia leptocaulis	3.1	0.4	0.3	.2	0.7	—	36.9	6.7	35.9	T	0.3
Optunia lindheimeri	1.5	T	0.1	.3	0.2	.4	54.0	13.3	5.1	T	0.3
Pithecellobium flexicaule	0.4	—	T	—	T		T	—	T	—	0.1
Prosopis glandulosa	78.8	36.0	34.6	10.9	24.6	14.2	3.2	4.4	5.1	12.5	55.9
Prosopis reptans	0.4	0.8	0.1	—	6.0	—	1.6	—	10.3	T	1.3
Quercus virginiana	—	14.3	—	23.8	—	31.7	—	—	—	—	—
Zanthoxylum fagara	1.6	7.0	4.2	11.7	3.1	12.1	2.1	62.2	T	37.5	2.5

On the plowed areas, only a few scattered plants of the most resistant species remained. Prickly ash, mesquite, and granjeno were the most abundant brush species on the plowed areas of sandy soils while mesquite, creeping mesquite (*Prosopis reptans* Benth.), huisache, and *Lycium* species were the most abundant on clay soils.

Change in forage preference

Most South Texas brush plants are considered to be relatively unpalatable to livestock and game animals. However, one of the major factors limiting their use by animals is not their palatability, but the morphological adaptations that prohibit easy browsing. Almost all the plants are armed with heavy, sharp thorns or spines. In addition, these plants grow together in dense clumps or mottes. Only a few twigs on the outside of the clumps can be reached by animals, and these are usually protected by the spines of the plants.

As soon as the treated plots were cleared of brush, both deer and cattle concentrated on the areas. Cattle were observed to graze so-called "unpalatable" plants. Almost all plants, regardless of their previous palatability, were used by both domestic and wild animals.

Forage preference values increased from 2 to 10 fold with top removal of most species on clay soils. (Table 3). Only blackbrush, prickly pear, and tasajillo failed to be increased in preference value by brush treatment.

TABLE 3. PREFERENCE VALUES OF ALL WOODY PLANTS ON TREATED AREAS IN SOUTH TEXAS

	Check	Mowed	Roller Chop	K-G Blade	Root Plow	Root-Plow & Rake
Victoria clay	1,330	12,755	12,670	9,660	4,000	8,820
Miguel FSL	4,721	—	19,205	25,575	915	1,000

On untreated areas, huisache was the most preferred browse species. However, on areas where the tops had been removed, lote, brazil, prickly ash, granjeno and agarito were utilized in amounts comparable to huisache.

The increase in preference values with treatment was especially high among such "unpalatable" plants as agarito and lote bush. Agarito has the typical prickly leaves of the genus *Berberis* and is seldom taken by animals in the mature state. However, the young shoots were sought out by both deer and cattle while the leaves were soft and immature. Likewise, plants such as lote are armed with large, stiff, sharp pines. Browsing of a mature plant is almost impossible. However, in the young, tender shoot stage it became a preferred forage species. Even the preference value of the despised mesquite increased 60 fold following mowing.

Plants on the sandy soils responded in a similar manner to the brush treatments. Chittimwood and Mexican persimmon were changed from relatively unpalatable species to some of the most preferred species. The preference value of huisache increased less than that of several other brush species after treatment.

Palatability, and ultimately the preference value of a plant, appeared to be related to the succulence of the species. Only the leaves were eaten from mature plants, and they were often difficult to remove from the plant, due to the spines. It appears that the key to increasing use on the South Texas brush plants is to keep them in a succulent stage.

Forage value

Utilization and preference values were increased greatly with brush control treatments although the total amount of brush production was reduced due to the resulting decrease in density of the woody plants. However, the forage value of the brush increased. Forage value is a function of preference by animals and of availability of forage, not just total production.

The forage values of woody plants on the root-plowed and root-plowed and raked areas were greatly reduced, because brush populations were almost destroyed.

The mowing, chopping, and scalping treatments actually increased forage values of the woody species. Mowing increased the value of brush for forage almost 8 fold on Victoria clay; a 6-fold increase was obtained by roller chopping, and a 4-fold increase resulted by scalping (Table 4). Mowing removed all of the top growth. The material removed was shredded into fine particles and spread back onto the soil. As a result, the stumps of the treated plants were cleanly cut about three inches above the ground. There was no slash for shading the new regrowth. Prolific sprouting from the base of the stump resulted in a thick, low cover of succulent shoots where dense, woody plants had grown previously.

Chopping broke or cut the plants from the stump at various

TABLE 4. FORAGE VALUE OF WOODY SPECIES ON BRUSH CONTROL PLOTS IN SOUTH TEXAS, 1964

	Check	Mowed	Roller Chop	K-G Blade	Root Plow	Root-Plow & Rake
Victoria clay	25	196	160	108	6	13
Miguel FSL	165	—	255	260	9	6

heights. Some plants were cut at or below the ground surface; others were cut 12-14 inches above the ground. The litter from the clearing operation was left where it had fallen. In some instance it shaded the regrowth; in others it prevented animals from browsing the new shoots. The result was a rather ragged cover of low-growing shrubs protruding from the slash left by the chopper.

Scalping with the K-G blade sheared the plants off near or slightly below the soil surface. More brush plants were killed by scalping than by mowing or chopping; therefore, less resprouting occurred on the scalped areas than on the mowed or chopped treatments. Although the plants on the scalped area were fewer in number, they were highly palatable and completely available.

The increase in forage values of brush plants was not as dramatic on sandy soils as on clay soils (Table 4). Forage values were increased by 56% through roller chopping and 59% through the use of the K-G blade. Mowing was not used in the sandy site.

Several factors contributed to the difference in response between soils. First, more plants were killed by the treatments on the fine sandy loam; hence, less density. Second, more of the untreated plants were utilized on the sand than on the clay soils.

While all species were increased in forage value on clay soils, mesquite, huisache, and lote actually decreased in value on the fine sandy loam.

The overall increase in forage values on the treated areas was due primarily to two factors. First, the succulence and palatability were increased, resulting in improved utilization and preference values. In addition to the increase in palatability, the availability was increased. The dense, heavy mottes of woody material were destroyed. Plants on the interior of the mottes were made available to animals.

Tall plants were knocked down; where high-lined trunks had been, lush sprouts became available. The thorn-armed woody limbs were replaced by new leafy shoots.

The combination of making plants more palatable to animals and at the same time more available to them actually increased their value for food plants while reducing their canopy surface.

DISCUSSION

One of the main goals in a brush control program is to reduce the amount of surface of the plant. By reducing the surface area, less water is lost through transpiration; more is available for grass growth. By removing the top growth of brush, the time required for working livestock and other practical ranching operations is reduced.

Therefore, most ranchers have sought the most permanent method available for reducing brush cover.

When a semi-permanent method of brush control, such as root-plowing, is used, the protective cover for wildlife may be reduced for many years. Not only is wildlife cover destroyed, but many of their food plants are also temporarily destroyed. In addition, most grass plants that are underneath or between the woody species are killed.

The temporary methods of brush control, such as mowing, chopping, or scalping, have not found much favor with the ranching industry. The rapid regrowth of the readily sprouting brush plants has caused livestock operators to look for a more permanent control method.

However, in doing so, they have largely overlooked the value of the browse plants on the treated areas. Browse plants are not generally considered of any importance for forage in South Texas. They are simply brush—woody weeds. However, the value of woody plants for forage in South Texas is not limited totally by their palatability, but by their availability. When the woody, thorny stems are removed, both livestock and deer eat the new growth.

The palatable browse from the regrowth of the woody species may be useful to the animal industry in South Texas. Periodic droughts occur in the area and may last for months or even years. During these dry periods Vitamin A becomes critical on the dry grassland ranges. Green, palatable shoots from the browse plants could aid in eliminating the Vitamin A deficiency.

A "temporary" treatment such as mowing may actually increase the value of the brush for forage as much as 8 fold. Even though the plant is not killed, its transpiring surface is reduced significantly, and the troublesome tops are removed so cattle can be worked. The grass sod has not been disturbed. The only disadvantage is that the plants have not been killed—the control is only temporary.

Wildlife managers have objected to brush control on the grounds that control removes the protective cover for wildlife. The temporary nature of the mowing and chopping techniques may be an advantage if wildlife is to be raised. Our experience indicates that the first year following mowing the brush is sufficiently high for quail and turkey nesting and the protection of deer fawns.

Indications are that in three to five years, brush will be sufficiently high to shelter adult deer and javelina.

No brush control technique is permanent in South Texas. It is only a matter of time until brush will re-establish itself on controlled areas. Therefore, the rancher must consider brush control as a maintenance item in his budget. Brush must be re-treated as posts must be replaced in a fence.

It is entirely possible that the maintenance cost of mowing brush every three years may be less than a root-plowing treatment each 15 years. In addition to decreased cost, the temporary control methods offer the additional advantages of continuously suitable wildlife habitat and increased forage value from the woody species.

If a rancher chose to raise wildlife as well as livestock, he could treat approximately one-fourth of his land each year by mowing or roller chopping. By arranging his treated areas in long strips throughout the ranch, he could be assured of adequate cover for his wildlife, an increase in edge effect, and adequate forage for his animals. Other systems can be designed for specific purposes.

Mowing or chopping for temporary control of brush has been demonstrated to be feasible in South Texas. The principle may be applied anywhere a brush problem exists and an inexpensive, temporary control method is available.

Range technicians have stopped advocating eradication of brush. Now, control is the word. Perhaps we need to look past the simple concept of control to a concept of management of brush. We have many tools available for the reduction of brush stands. We know that each brush species responds differently to a particular method of control.

The challenge is to put together the species, the methods, and the responses to obtain a stand of plants in the combination and condition most desirable for our purposes. We are limited in the design of new systems of brush management only by our own imagination.

SUMMARY

Much of South Texas rangelands is covered by a chaparral complex that is considered relatively unpalatable to livestock and game animals. Large acreages of this brushland are cleared annually by various techniques with the expressed goal of eradication of the brush cover. Such complete removal of brush not only destroys game habitat, but removes the woody species as forage plants.

During the summer of 1963, 5 treatments of commonly used brush techniques were established on clay and sandy loam soils of the Rob and Bessie Welder Wildlife Refuge in order to study the relative merits of brush management techniques. Methods used were mowing, roller chopping, clearing with a bulldozer and KG blade, root-plowing, and root-plowing and raking.

All methods reduced cover significantly. The root-plowed areas and the root-plowed and raked plots reduced the brush population to the

point where it had no significant value for forage. Mowing of brush increased forage values 8 fold over the check, roller chopping increased brush forage values 6 fold, and removing with a K-G blade increased forage values 4 fold on clay soils. On sandy loam soils, roller chopping and K-G blade removal of brush increased its value almost 2 fold, root-plowing and root-plowing and raking reduced forage values almost to zero, and mowing was not tested.

Browse preference values were increased on all species of woody plants by treatments used. Highest preference values were for plants that resprouted vigorously after their tops had been removed.

Brush management, or control of woody plants, appears to be more desirable from a livestock-game standpoint than attempted eradication of brush on South Texas ranges. Removal of brush tops by relatively inexpensive methods increased forage values and preference ratings of brush plants and did not permanently destroy wildlife cover.

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DISCUSSION

DISCUSSION LEADER MOSBY: That was an excellent presentation and I am sure that there may be questions which you would like to ask Dr. Box about some of the procedures and techniques.

MR. VAL LEHMANN (King Ranch, Texas): You said you improved conditions for deer by mowing. In your computations did you take into consideration that you are losing the mast that would have been produced by mature plants by this mowing process?

DR. BOX: No, we didn't, Val. We made no measurement on the mast of those plants, and some of them do produce rather valuable masts.

MR. LEHMANN: That has been one of the big defects of brush control. Each of these plants produces masts which can be used. In the case of mesquite the plants often produce more food in mast than the grass in dry times and I think these things should balance one another in these computations.

Also I think control is what the boys have used all this time mainly for the reason that what they have said would work, doesn't. In South Texas with all this range renovation and conservation we are rapidly approaching the time when our woody cover will be almost exclusively cactus and other undesirable species. It is a real problem. It never was good cow country and never will be good cow country. Nobody has made money in the cow business for many years. This tremendous government program has done little more than reduce the wildlife carrying capacity of our ranges without a corresponding increase in livestock carrying capacity. I think the time is past due to realize that brush is not the number one factor in controlling grass; the number one limiting factor is climate. The second is undesirable soils. Brush competition is way down on the list and a whole re-evaluation of these operations should be made.

DR. BOX: You said something which I think is important, about changing to a stand of cactus. We found that this is real true. The brush control people may not like for me to read this into the record, but I shall.

"On both sites, cactus density increased greatly on the root-plowed areas. Tasajillo increased approximately 720 percent (Tasajillo is a little, short cactus we have in South Texas) on the Victoria clay and 50 percent on the sandy loam."

We found this on almost all of our treatments where we had any sort of severe soil disturbance. We get an increase in tasajillo and prickly pear.

MR. LEHMANN: We have thousands of acres where soil texture was good for game and steers before the range managers got hold of it. Now it is becoming a part of the country where hardly a snake can live. We have changed our fauna from white-tailed deer, wild turkey, scaled quail, and bobwhite quail to cactus and cotton rats and weeds. Brush control is ruining the cow country and so the people are fighting these things. What the answer is after you root plow this three times, as we have done on the King Ranch and have pure cactus, I don't know, and nobody else does.

DISCUSSION LEADER MOSBY: I presume that was a statement, not a question. Are there any other comments or any other questions?

As I am not familiar with this procedure I should like to know do you have any approximate figures as to the range within which costs of these control measures fall?

DR. BOX: Yes. I can furnish figures on cost per acre. Mowing with farm tractors, we figure costs us about $1.50 per acre. We used our own equipment and figured depreciation and so forth.

The rest we contracted. The roller chopping runs from $3 to $5 per acre, depending on the size of the area. The scalping with the K-G blade the root plowing from $10 to $15 per acre, and the root plowing and raking from $15 to $20 per acre depending upon the contract.

DEER-BROWSE PRODUCTION AND TIMBER-STAND IMPROVEMENT IN NORTHERN HARDWOODS

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A selection of major problems for habitat research in Northeastern forests, made by the Forest Service a few years ago, listed habitat-timber relations first. It also emphasized the close relationship between the management of forest land for timber production and its management for game.

Nowhere is this close relationship more evident than in the use of cutting practices. There are many examples of the striking response of forest game populations to changes in the habitat after cutting.

But if the cutting is carried out without integrating it with the needs of wildlife, the changes ultimately result in an unmanaged habitat, with little possibility of control over the kinds of game that are produced. The only recourse in such instances is to set game regulations to harvest the species that respond best to an unmanaged habitat.

The effects of past cutting practices have finally led to what may be the most promising opportunity in forest-habitat management in the Northeast today. This is the growing acceptance of even-aged management in northern hardwoods. A large proportion of these widely distributed stands are now essentially even-aged. The key to coordination of timber and habitat management in these stands is in the method of cutting (and the size and distribution of the cuts, and the cutting cycle) used to bring about an orderly turnover of stands under even-aged management—from clear cutting for regeneration in mature sawtimber to intermediate cutting in the younger age classes. Most northern hardwood stands are in poletimber sizes, apparently of low value for most wildlife. For example, browse production for deer is generally low, and sometimes negligible.

This paper is concerned with a method of intermediate cutting that yields deer browse as well as better timber. It is currently in use on the Allegheny National Forest in 20-40 and 40-60-year-old Allegheny hardwood stands.

This forest type differs from the common northern hardwoods (beech, birch, maple) primarily in that black cherry replaces yellow birch in importance. The procedure in using the method is to fell all stems except the future crop trees. A special effort is made in cutting to hinge the stem to the stump in order to extend the life of the top for browse production in subsequent years. In 20-40-year-old stands, the spacing between crop trees is about 16 feet; in stands 40-60 years old, the objective is a residual basal area of about 80 square feet per acre, the same as that prescribed when any other thinning method is used. A 40-60-year-old stand the first year after cutting is shown in Figure 1.

The cuttings are made in blocks, usually of about 10 acres, and spaced 30-40 chains apart. The use and location of cuttings are determined after wildlife needs have been integrated in overall compartment planning. The general objective of cutting is to realize an improvement in wildlife habitat by providing more deer browse and by increasing the amount of small-game food and cover.

A study to determine the yield of browse by this method in 40-60-year-old stands was begun in the summer of 1964. This is a report of results the first year after cutting.

Figure 1.—A 40-60-year-old poletimber stand in Allegheny hardwoods the first summer after felling all stems except crop trees.

STUDY OBJECTIVES

The primary objective of the study is to obtain an accurate estimate of the quantity of woody browse produced by this method. The inference to be drawn from this estimate is that it apply to all 40-60-year-old Allegheny hardwood stands thinned in a similar manner. Since this type is closely related to other northern hardwood timber types, the estimate should approximate the yield of browse in all northern hardwood stands of the same age class thinned in the same way.

The secondary objectives of the study are to obtain an estimate of (1) the quantity of woody browse produced by origin of growth (tree tops, sprouts, and seedlings), and (2) the quantity of browse utilized by deer. The inferences from the estimates of production are the same as that for the primary objective; those for browse utilization are limited to the Allegheny National Forest since the amount of browse utilized depends on the level of the local deer population.

The quantity measured is the number of twigs of browse produced each year during the effective life of the cutting, or about 5 years.

DESIGN AND METHODS

Four blocks were selected on the Allegheny National Forest which were thinned by the method in the mid-winter of 1963-64. Because the method was adapted only recently, a choice among areas was somewhat limited. However, the four blocks, varying in size from 6 to 13 acres, were located on three Ranger Districts, thereby providing good distribution. The cutting was done by the Pennsylvania Game Commission under a cooperative working arrangement with the Ranger Districts whereby the latter marked the trees to be left uncut. Good use of the browse was sought by locating blocks for thinning in the vicinity of areas where deer concentrate in winter. Such areas invaribly show evidence of heavy browsing.

Woody browse was measured during the first 2 weeks in August 1964. Browse available the previous winter was distinguished from that available during the growing season. The unit of measurement was a single twig. All twigs with current growth over 1 inch long between ground level and 5 feet were counted on permanent 0.01-acre circular plots. Twigs in tops, stump sprouts, and other sources were recorded separately, and also whether they were browsed or unbrowsed. The sum of browsed and unbrowsed twigs equalled production. Because of a general scarcity of browse other than that in tops and stump sprouts, counts of root sprout and seedling twigs were incorporated into the two main categories in calculations of first-year data. Leaves were not included in the measurements.

It was estimated that measurement error would be small because only a count of twigs was required; so no allowance was made for this source of error. However, some undetermined but presumably small error was introduced in counting twigs on plots with a high density of tops.

Related unpublished studies by the Northeastern Station show that browse populations are inherently highly variable, and large samples are required for accurate estimates of population parameters. For this reason, 30 sample plots were established in each of the four blocks by a randomized design, so that estimates of the number of twigs were based on a sample of 120 plots. The 95-percent confidence interval was specified for the estimate of total twig production. A 10-percent allowable error of the mean was also specified. The confidence interval for other estimates of production was also 95 percent; the allowable error of these means was not specified.

The quantity of browse produced and utilized was also determined in pounds per acre. This was calculated from a weighted average of 0.22 gram per twig for all twigs. Twigs were oven-dried for 3 hours at 105° C. The weighted average was derived from the dry weight of twigs by species, season, and origin of growth. Weight per twig for each species was determined from some 700 twigs clipped and dried in this study and over 1,200 twigs similarly treated in other current studies by the Northeastern Station. In all but two instances, the dry weight per twig for each species was less than 1/3 gram. The method described by Shafer[1] was used in collecting twigs of most species. With this method, only that portion of the current annual growth of a twig browsed by deer is collected. This is determined by clipping unbrowsed twigs to a diameter previously determined by measurement of a large number of browsed twigs.

RESULTS

Total production of woody browse for the first year from all sources was over 141,000 twigs per acre. Of this, more than 97,000 twigs (69 percent) were in tops available to deer the same winter as cutting. The balance of nearly 44,000 twigs (31 percent) was divided between tops (24 percent) and stump sprouts (7 percent) that became available to deer in the first growing season in 1964. This new growth of twigs constitutes the supply of woody browse available to deer through the winter of 1964-65 and until the second growing season in 1965. The data are summarized in Table 1.

The accuracy of the estimate of twig production for the first year, and the estimate of the yield of twigs in tops the first winter is reasonably high, and both estimates can be used with confidence (Table 1). Although the allowable error specified in the objective was slightly exceeded, there should be no serious limitation in the use of the estimate.

There was a marked decline in production of woody browse from the first winter to the first growing season. It reached 65 percent and was due largely to mortality of tops laid down the previous winter. A sampling in the summer of 1964 of some 580 stumps from stems 1 to 12 inches d.b.h., distributed among 10 species, showed that despite the effort by cutters to hinge the stem to the stump, 36 percent of all trees felled the previous winter were completely severed. Of 372 stems that were still attached after cutting, nearly one-third (31 percent) died before or during the first growing season. Thus total mortality of tops from both causes was found to be 56 percent.

Sugar maple was the most abundant species in the twig population

[1]Shafer, Elwood L. Jr. The twig-count method for measuring hardwood deer browse. Jour. Wildlife Mangt. 27: 428-437, 1963.

sampled. More than one-half of the twigs in tops and nearly two-thirds of the stump sprouts were of this species. Beech was next in abundance, followed by red maple, ironwood, yellow birch, black cherry, black birch, and white ash.

Utilization of twigs by deer (Table 1) varied with the season and origin of growth. About one-third of the twigs in tops the first winter were browsed, while in contrast only about 12 percent of twigs in tops in the summer were browsed. Use was highest for stump sprouts: about three out of five were browsed during the first growing season. In sugar maple, by far the most numerous among stump sprouts (64 percent), browsing in late spring and summer reached 66 percent. (Utilization during the winter of 1964-65, when measured, will increase the overall utilization rate for the first year.)

TABLE 1. PRODUCTION AND UTILIZATION OF TWIGS OF DEER BROWSE, BY SEASON AND ORIGIN OF GROWTH FOLLOWING A MODIFIED METHOD OF INTERMEDIATE CUTTING IN ALLEGHENY HARDWOODS

Item	Twigs per acre	95% Confidence limits %	Percent of total twigs	Twigs browsed %
	FIRST-WINTER BROWSE			
Tops:				
Browsed	33,403	—	—	34.2
Unbrowsed	64,262	—	—	—
Total	97,665	±14	69	—
	FIRST-SUMMER BROWSE			
Tops:				
Browsed	3,920	—	—	11.6
Unbrowsed	29,998	—	—	—
Total	33,918	*	24	—
Sprouts:				
Browsed	5,819	—	—	58.5
Unbrowsed	4,124	—	—	—
Total	9,943	*	7	—
	ALL BROWSE			
Browsed	43,142	—	—	30.5
Unbrowsed	98,384	—	—	—
Total	141,526	±15	—	—

* ± 23% for tops and sprouts combined.

The weight of browse production for the first year was calculated from the estimate of total twig production per acre and a dry weight per twig of 0.22 gram. Using these values, the total yield of browse twigs from all sources was 69 pounds per acre. Most of this was in tops laid down the first winter; the yield here was 56 pounds per acre, and the average dry weight per twig was 0.26 gram. Twig growth in tops the first summer was slow, and the size of the new twigs generally was small. The dry weight per twig was 0.09 gram, and the yield per acre was 7 pounds. The balance of 6 pounds per acre was in stump sprouts. These averaged 0.27 gram, dry weight, per twig.

DISCUSSION AND CONCLUSIONS

The data indicate that this is an effective method of integrating browse and timber production in northern hardwood poletimber stands. If used on 10-acre blocks in 40-60-year-old Allegheny hardwoods, it will yield a total of about 1,400,000 units of woody browse in the first year. It is likely that in other northern hardwoods of the same age class the yield will be about the same. This does not include the production of important leafy browse material.

Production will be considerably lower in the second year, but the diversity of deer foods should be greater with the addition of some seedling, shrub, and herbaceous growth.

The full effectiveness of the method will be determined by the extent to which it satisfies its primary purpose in resource planning. If this is to increase the harvest of deer by attracting them to the cutting area, the measure of success is the kill; if it is to relieve deer damage in timber regeneration areas, the measure of its success is similarly apparent. The method may also be employed to reduce winter losses of deer, to improve their general condition or productivity, or to reinforce the browse supply and prevent the development of serious problems. Whatever the purpose of its use, the method will be a more valuable tool if it is used together with proper deer harvests. This is of special importance if the objective is to promote range recovery and improve small-game habitat.

Resource planners also hope that they can use these cuttings in large tracts of poletimber where regeneration clear cuttings will not be made for many years. Individual areas which produce good amounts of browse for as little as three years will be valuable. Then a series of cuttings succeeding over a period of time can sustain a deer population until timber sales can be made. In this way, the land unit remains more productive until a better balance of age classes evolves.

A comparison of the number of twigs with the weight of twigs produced raises a question as to which is the better way of expressing browse production. We favor using the number of twigs, for several reasons. The results should have broader use because the unit of expression has the same stability as the unit of measurement while weight per acre employs an average weight per twig, which depends for its determination on the extent to which deer browse each twig. And this is influenced by a number of things, such as the density of the local deer population, the quantity of browse available, the season of use, and other variables. Their combined effect may greatly restrict the inferences that can be drawn from the results. It seems more useful to first determine browse yields in a standard unit (twig count) for general use, which may then be converted to some other unit (pounds) to describe a local condition.

We also favor number of twigs because it is less likely to mask the qualitative attributes of browse. All twigs, regardless of size, are equally considered. This is justified by the fact that deer usually take much less than the annual growth, and very often only the tip from twigs with a foot or more of current growth. Deer also regularly take a twig section which, if converted to green weight, would require more than 4,000 to equal 1 pound. It is also true that sections of twigs may be taken which require as few as 275 to equal 1 pound (white ash in winter tops in this study, for example). But if the weight of woody browse were the only important factor, it is likely that deer would consistently browse much more of the current growth of the heavier twigs and avoid the small, fine twigs. Palatability and nutritional content of twigs probably are important factors in determining both the selection and the amount taken from any twig.

The Department of Animal Industries and Nutrition, Pennsylvania State University, is currently cooperating with us in an exploratory study of the protein content of certain woody browse species. They found that the crude protein content of the 2-inch tip of twigs of 7 species of hardwoods averaged 31 percent higher than that of the adjoining 10-inch section of the twig. The range of the differences in protein content between the tip and the 10-inch section in the 7 species analyzed was from 6 to 67 percent.

Our choice of the number of twigs also avoids the general tendency to equate woody browse production with the carrying capacity of a unit of range—as is the case with pounds of browse per acre. Deer are variously credited with consuming 2 to 3 pounds, dry weight, of woody browse per day. The inference that usually follows is that a yield of 30 pounds of woody browse per acre will support 1 deer for 10 days, or even 10 deer for 3 days. But this is open to question. We have been unable to verify that this has been demonstrated for deer in nature. It is our opinion that woody browse is only part of a mixture of many food items used at all seasons of the year, and that while it may assume greater importance in winter, it is not an exclusive diet at any time.

Direct costs of cutting were not available in this study. However, past experience on the Allegheny National Forest shows that it is

$35-40 per acre. By contrast, the cost of girdling to release crop trees on two sides of the crown was found to average $10-15 per acre. The latter method, however, is a light thinning and does not provide as much release as does the one tested in this study. This leads to the general observation that a good hardwood pulp market would result in a very broad, significant increase in browse production. But this would not entirely replace opportunities to use the present method, which has a number of specific advantages.

An additional benefit of this thinning method was the food and cover created for small game species. The effectiveness of the cutting area for small game depends, of course, on its location in relation to other essential habitat components.

In the present instance it was a useful and much needed extension to coniferous winter cover used by grouse and hares.

SUMMARY

Opportunities for coordinating timber and habitat management in northern hardwoods should increase with the growing acceptance of even-aged management. A large proportion of northern hardwood stands are now even-aged. Much of this is in poletimber size—generally of low value for most wildlife. The key to coordination is in the cutting methods—and in the size, distribution, and cycles of cutting—used to obtain a better balance in age classes and an orderly turnover of stands.

A method of intermediate cutting to increase the production of deer browse and improve small game food and cover is currently in use in poletimber stands on the Allegheny National Forest. The method was tested for its yield of woody deer browse in 40-60-year-old Allegheny hardwoods. Felling all stems except the crop trees produced a total of 141,000 twigs of browse per acre in the first year. Tops in the same winter as felling yielded 98,000 twigs per acre.

Browse production expressed as number of twigs per acre is preferred for a variety of reasons. The method has a number of specific uses. Its most effective use in resource planning will be realized when integrating the needs of wildlife in the over-all compartment planning.

DISCUSSION

DISCUSSION LEADER MOSBY: We are running a little short on time. We do have time for several questions if you have them.

MR. JAMES MCCLELLAN (American Forest Products Industries): I would like to ask what pulpwood volume you are leaving on the ground there as an average?

DR. JORDAN: I can't answer that question too satisfactorily. This actually has use, especially when there is no pulpwood market.

MR. MCCLELLAN: I understand that. I was wondering what the volume was.

DR. JORDAN: I don't know exactly what the volume of pulpwood is.

MR. MCCLELLAN: We used to leave nine cords per acre of chemical pulpwood. It has the same effect.

DR. JORDAN: Of course we are trying to leave about 80 square feet. This isn't always possible.

MR. JAMES HILL (Texas): Did you notice any benefits to ruffed grouse in this program?

DR. JORDAN: Only by general observations. But the contrast in cover, of course, is very striking between a treated stand and an untreated stand. It does look good for grouse. But its effectiveness here, too, will depend on the location of this cutting in relation to other habitats for grouse. It has to be located in relation to these other components. This is also one of the considerations in locating stands or locating cutting blocks.

MR. DALE ARNER (Mississippi State University): Will you please repeat the number of clipped blocks that you used to measure the yield?

DR. JORDAN: The blocks we used to sample the browse? The total was 120 plots, 30 in each block, the blocks from 6 to 13 acres. It totals 120.

DISCUSSION LEADER MOSBY: We could entertain one additional question if we have it. Well, those of you who perhaps may not be familiar with the significance of this in the eastern forests, including the zone extending farther south than those referred to by Dr. Jordan, the game agencies have seriously considered in several states instituting pulpwood operations to secure essentially the same objectives that are referred by Dr. Jordan. So this is a game management tool that I am sure we will hear much more about.

WILDLIFE IN A MULTIPLE USE PROGRAM

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The public's right to hunt and fish on the public domain was recognized, and cooperation with State wildlife conservation agencies and sportsmen's groups was authorized in the Taylor Grazing Act of 1934. This Act introduced lawful controls and management to the public range land of the West .Today, after years of land disposal, the remaining 174 million acres of this land in the eleven western states is still larger than the area of Texas.

The Code of Federal Regulations (Federal Range Code), interpreting the Act, includes a requirement for reservation of sufficient grazing capacity of federal range for the maintenance of a reasonable number of wild game animals to use the range in common with livestock grazing in each district. Accordingly, it has been customary when allocating range forage for livestock on a given unit to estimate, by species, the numbers of big game animals present and calculate a forage reservation for them. This procedure could be improved with more intensive management and greater consideration of the animals' needs.

HIGHLIGHTS OF RECENT DEVELOPMENTS

The Classification and Multiple Use Act (PL 88-607) passed in 1964 by the Congress authorizes and directs the Secretary of the

Interior to classify the public lands administered by the Bureau of Land Management. All lands are to be classified either for disposal for certain purposes or for retention and management under principles of multiple use. This is to be interim legislation pending the implementation of recommendations to be made by the Public Land Law Review Commission (PL 88-606). One of the specified purposes for retention in public ownership is management for fish and wildlife development and utilization. Multiple use, as defined in the Act, recognizes the use of some land for less than all of the resources, and with consideration being given to the relative values of the various resources, and not necessarily the combination of uses that will give the greatest dollar return or the greatest unit output. The Act also provides for retention for preservation of public values that would be lost if the land passed from Federal ownership. Lands under this category might provide access to land or water areas having recognized multiple use values. Proposed criteria for retention and interim management of fish and wildlife purposes are to: (1) Provide an adequate area of hunting and fishing ground for the general public, or (2) Maintain habitat and food supply for the fish and wildlife population dependent upon the public lands and being maintained under federal and state programs. In accordance with the directive in this Act, BLM is actively inventorying the public land to identify it for its highest potential uses.

One enduring problem is that of access to the public lands through private holdings. This situation largely exists because of the scattered land-ownership pattern. An active land exchange program designed to block-up the largest public domain areas classified for retention tends to alleviate this situation but progress is necessarily slow. Valuable wildlife habitat must be given full consideration, along with other uses, in proposed land exchanges. In cooperation with state game and fish departments, the Bureau has identified and mapped the principal hunting and fishing areas on the public lands. This basic information will be invaluable to district managers as they pursue the access problem. Public lands need to be better identified on the ground—perhaps the Job Corps will be able to assist with the needed manpower. The Land and Water Conservation Act may authorize land acquisition funds for public access.

Western state game agencies are vitally interested in retention of important fish and wildlife areas in some form of public ownership for both hunting and fishing use by the public and for maintenance of habitat. In past years, specific areas of public land identified by other agencies, such as state game departments, as being valuable for wildlife management were often transferred to their jurisdiction under the Coordination Act or the Recreation and Public Purposes Act. BLM now considers that such programs for recreation or wildlife can be accommodated under its multiple use management program. If located within large blocks of public land designated for retention, BLM proposes to retain management but perhaps delegate some management activities by means of cooperative agreements. If the lands requested are designated for disposal, the Bureau will pursue whatever program is most appropriate to achieve interim management of the lands. State government programs are one qualifying criterion for disposal of federal land.

The Bureau is now engaged in coordinating its various functional plans into production of a single comprehensive resource management plan for each specified geographical area under a unit planning system. These will be long-range plans giving consideration to all of the multiple uses, including wildlife, occurring on the area. They will be more detailed for areas to be retained than for those classified for disposal. Priority of uses may be assigned to portions of units. Critical wildlife habitat, like other public values such as natural areas, recreation areas and critical watersheds, will be given the necessary degree of protection from competing uses.

Last year, BLM districts made a preliminary identification of the most important fish and game habitat areas on public lands as mutually recognized by the Bureau and the state fish and game agency. Results totaled approximately 30 million acres or somewhat less than 20 percent of the public domain. This mapping, showing major wildlife categories, depended largely upon the participation of local state game biologists. Refinement of this information will be a continuing process. All districts were instructed to begin using this information in planning and conducting a multiple use program. In Oregon, the Game Commission and BLM State Office had already reached agreement in 1961 to give special consideration to critical deer winter ranges designated by the state. This memorandum of understanding provides that BLM will advise the Commission of any plan to alter the status or character of public lands within certain designated big game winter ranges.

These areas will be included in planning-unit plans and they should be afforded priority treatment for wildlife. Having been identified for wildlife they can, for example, be given full weight with other resource values in considering proposed land exchanges, and in forest and range management and development programs. In addition, when funds permit, projects can be undertaken specifically to benefit fish and game.

Many of the usual forest and range development practices can be satisfactorily accomplished with a minimum of disruption to habitat. In fact, they often are beneficial to wildlife and the recreationist. Due consideration and care for these other values, both in planning and field operations, are required for attainment of these desirable results. In forestry, proper road location and culvert installation, clearing debris from streams, leaving streambank vegetation unmolested, and taking precautions to minimize erosion following road construction and logging all have a direct bearing on maintenance of stream-fish habitat. The logging of old-growth timber and thinning in second-growth stands in western Oregon results in much-improved habitat for big game animals.

On dry range lands, improvement practices commonly employed to permit better livestock management include: brush removal, grass seeding, gully control, water development and fencing. Many western ranges are in various stages of deterioration and reductions in livestock use have been made. Following a range-forage survey and adjudication of livestock use to adjust to the existing carrying capacity, the planned improvement practices are carried out within limitations of funds available. Although these developments are primarily to benefit livestock, wildlife also shares in them. Deer, antelope, sage grouse, chukars and other species are today utilizing many of these projects. Wildlife is receiving more and more consideration. For example, all BLM proposed sagebrush control projects are reviewed by the State game agencies and their suggestions have been accepted. Important deer winter ranges are carefully avoided. The short sagebrush species utilized by antelope are not treated. Even within approved project boundaries, portions such as creek bottoms, rimrocks and stands of preferred browse are unmolested. Henceforth, all projects using chemical controls must have prior approval of a departmental preview committee and they also may be referred to the Federal Committee on Pest Control. A few years ago, at BLM request, the Oregon Game Commission initiated a continuing evaluation of our range improvement practices, concentrating particularly in the large Vale Project. We enjoy a close working relationship between our two agencies and friendly cooperation is commonplace.

We can cite further examples such as the attraction of antelope and deer to grass seedings. Where needed by big game animals, adapted varieties of palatable herbaceous plants often have been included in a seeding. Hundreds of pounds of browse seed, frequently donated by the State, have been planted. In antelope country fences are designed to permit these animals to pass. Springs have been developed cooperatively including the fencing of overflow areas to permit growth of bird cover. Troughs and open tanks are provided with escape ramps for small wildlife species. Pipelines have been tapped to make water available to wildlife. These are indications of the consideration accorded fish and game and the benefits accruing to them from the forest and range conservation programs.

Following the identification of important big game ranges, an inventory of the vegetation is a basic step to more intensive management and development. A beginning was made in Oregon last summer when a trained BLM survey crew rated and mapped the browse cover and its condition on two important mule deer winter ranges.

PLANS FOR THE IMMEDIATE FUTURE

Authorization of funds for wildlife habitat development will begin in fiscal year 1967. In the past and at present, improvement in fish and game habitat on the public domain has been an incidental feature of other programs or has been due to contributions, usually from the state fish and game agency. Actually, the greatest potential for improvement rests with the modification of established uses and development programs concerning related resources. Projects designed primarily or exclusively to benefit wildlife can be accomplished most appropriately through coordination with wildlife agencies. Cost-sharing agreements for specific projects will be emphasized.

Research is not a BLM function but where needs are identified and funds are available studies can be conducted under contract with research people. A review is underway to determine what current research by other agencies will meet these needs. Wildlife problems being studied for the Bureau range from mammals damaging tree reproduction in West Coast forests to improving fence specifications on antelope ranges. Field personnel have been requested to submit proposals for needed research.

There is a real opportunity ahead for wildlife where range rehabilitation is succeeding in producing sufficient grass to meet present livestock demands. On some allotments livestock reductions have been restored. With plenty of good grass and water on the improved pastures, livestock grazing pressure should be reduced on preferred wildlife and recreation areas. It is most important that big game animals share in benefits from excess forage. It is especially pertinent to the improvement of mule-deer winter ranges. This can be accomplished, not by exclusive use, but by fencing key browse areas and coordinating with the livestock management plan to control season and duration of livestock use so as to favor wildlife forage plants.

Public values, including wildlife, will receive priority treatment on sites designated as of special importance for these purposes. Their total area will be a minor percentage of the entire public domain, but their locations are fixed. Nature selects the sites for deer winter concentrations, campgrounds and fishing holes, and these are not easily translocated. Wildlife rarely demands exclusive use of land, but if several uses are to be compatible, all must be properly managed.

The key word in BLM's wildlife program is cooperation. One coordinated plan for the management and development of all resources of a given area is realistic, provided all lawful uses receive attention commensurate with their importance to the public. The States' regulatory authority over resident wildlife is recognized; BLM's responsibility is to provide habitat. Thus wildlife management and development on public lands require coordination of programs. A high degree of cooperation among federal and state agencies, sportsmen, and other interest groups is essential if we are to effectively put into practice the multiple use concept now authorized for our public lands.

RESPONSE OF KAIBAB MULE DEER TO RESEEDED FOREST AND MEADOW[1]

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North of the Grand Canyon of the Colorado River lies a flat-topped mountain surrounded by canyons or desert. This is the Kaibab Plateau, home of one of the most famous mule deer herds in North America. The Kaibab is often used as a prime example of mismanagement of deer and abuse of deer range. Today it is fast becoming an example of good habitat management, federal and state cooperation and good multiple use of forested land. Some of the lessons learned from past misfortunes and mismanagement are being applied.

The Kaibab became famous after a large proportion of this deer herd starved to death in the late 1920's following a period of protection from hunting, from predation, and from livestock competition. The winter range received the greatest damage from this irruption (Mann and Locke, 1931). The winter and winter-intermediate ranges were rehabilitated by joint Forest Service-Game Department efforts but control of herd numbers was not accomplished. A second

[1] Contribution of the Arizona Cooperative Wildlife Research Unit: University of Arizona, Arizona Game and Fish Department, Wildlife Management Institute, and U. S. Bureau of Sport Fisheries and Wildlife cooperating.

die-off followed another classic irruption of deer numbers in 1954-1955 (Swank, 1958). Range rehabilitation efforts have since been centered on summer ranges. It was the purpose of the present study to evaluate these efforts.

A most interesting and pertinent history of the Kaibab herd and its management was published by Russo (1964). He pointed out that in the last century the physical environment of this area has not been changed appreciably except in vegetative character. Unlike other areas no farms, nor cities, nor other activities of man have encroached upon either summer or winter range and no migration routes have been severed. He agrees with Rasmussen's earlier opinion that the deer themselves have been one of the few major influents on the vegetation in their environments (Rasmussen, 1941).

Recent changes in the summer environment have, however, been caused by both man and nature. In 1958 a freak windstorm uprooted and flattened 900 acres of spruce, fir and aspen. A second "blowdown" of 400 acres followed in 1961. Merchantable timber was salvage-logged and the debris bulldozed into windrows and burned before the area was aerially reseeded. Deer quickly found and utilized the plantings and the natural sprouts of aspen and other native plants.

Extensive logging did not begin on the North Kaibab until 1948. Until these blowdowns occurred the timber sold was ponderosa pine from lower elevations. The spruce (*Picea pungens, P. Engelmanni*) and fir (*Pseudotsuga taxifolia*) salvaged here demonstrated to the timber operator the merchantability of these species. Logging has since continued at higher elevations in mixed conifer types which include spruce, fir and pine. A total of 15,000 acres has been logged in this type since 1948 (Hodgin, 1964). It was in this high elevation timber type that the deer naturally congregated during the summer. Reseeding disturbed sites in the selectively logged areas has added further feeding areas for the deer herd. Virgin stands have little if any ground cover beneath the forest canopy and the deer found little food in the unlogged mixed conifer. The deer frequented the many mountain meadows between timbered ridges but used the forest primarily for cover.

During the years of recorded history of the North Kaibab few major fires occurred. In 1960 the inevitable finally happened: a lightning fire began in Grand Canyon National Park and swept north from the top of the plateau to almost the bottom on the east side and blackened 9,000 acres before it was controlled. This burn and the adjacent cleared fire lanes were reseeded by air and the roads were again reseeded after salvage logging. The reseeding mixture for the higher mixed conifer timber type included orchard grass (*Dactylis glomerata*), smooth brome (*Bromus inermis*), timothy (*Phleum pratense*), elderberry (*Sambucus melanocarpa*), and rhyzoma alfalfa (*Medicago*).

In addition to these recently created openings in the high forests, the extensive natural meadows are important both to deer and to cattle. Unfortunately past overuse has drastically reduced the productivity of many meadows. Rehabilitation of such areas was begun in 1962 when 673 acres of depleted meadow were plowed and planted to grasses, legumes, and bitter brush (*Purchia tridentata*). Cattle were kept off of these meadows in 1962, 1963, and until July of 1964. The resulting plant growth was good in spite of some erosion caused by heavy summer thunderstorms. Deer use of the seeded meadows has increased considerably during the last two summers. Other meadows had earlier been cleared of encroaching young tree reproduction around their edges. The bare areas created by the bulldozer on approximately 2,900 acres have been seeded to grasses and forbs (Hodgin, 1964).

The objective of this study was to measure the benefit to the deer of revegetating the burned, wind-damaged and logged forest and rehabilitating the meadows.

METHODS

Field studies were conducted in June and July each year from 1962 through 1964 on the higher summer range. At this time of the year the deer were relatively easy to find during their normal feeding periods. They usually fed during the first four hours of daylight and the last three hours before dark. It was possible to observe what a deer was eating with the aid of a 20-power spotting scope or even with binoculars. They showed little fear of a person on foot or in a vehicle at fairly close range. The time spent in cropping individual kinds of plants was recorded in minutes and fractions of a minute following the feeding-minutes technique described by Buechner (1947). The total accumulated time spent in feeding on each species was the basic measure of desirability of that species. The majority of the field time was spent in areas disturbed or reseeded to find which of the planted species the deer selected, but wherever deer were observed their food choice and feeding time was recorded. If there was doubt as to which plant a deer had been consuming, the observation was verified by inspection of the feeding site for forage removed. Frequently feeding time had to be discarded when the exact plants could not be found.

A general comparison of plant composition between areas and between the years of the study was needed. Did the deer select plants because they were the ones most abundant or did they seek out ones less abundant? How fast did plant succession replace the planted species with native plants and did this affect the choice of food by the deer? A series of line-intercept transects was established following the method of Canfield (1941) to answer these questions. A set of ten 100 foot transects were set out in 1962 at one-tenth of a mile intervals in logged mixed conifer, in logged ponderosa pine, in cleared mixed conifer (fire line) and in burned mixed conifer. These transects were read each year in June on approximately the same date. They yielded the total amount of ground cover and showed what proportion of the ground cover was made up by each plant species present within the reach of deer. These transects also yielded information on food selection by deer and cattle from evidence of animal use on the plants. Tracks in the soft ground often made it possible to tell whether deer, cattle or both had fed.

Additional field data included observations of deer condition and behavior, of their reactions to weather, to logging and other activities of man and of the abundance of deer in different habitats.

RESULTS

Disturbed and reseeded sites produced the most deer food and were preferred by the deer to natural undisturbed areas. The deer preferred early growth of orchard grass, June grass (*Koeleria cristata*), and wheat grasses (*Agropyron*) and they also fed on clover (*Trifolium*), dandelions (*Taraxacum*), and other forbs found on the disturbed soils. Deer were attracted to logged, burned, and blowdown areas that had been reseeded as well as to the rehabilitated meadows. Reseeding attracted the deer to a surprising extent. Table 1 shows the choice of the deer in terms of the number of minutes of feeding time on grasses, forbs, and trees or shrubs from all areas where they were observed. It must be remembered that the majority of the feeding time was gathered in planted areas.

Young orchard grass was the number one food choice by this measure in 1962, in 1964, and for the three-year total. It did not remain palatable much after July 1 in most areas and the deer generally would not feed on it beyond the "boot" stage. Aspen (*Populus tremuloides*) was the first choice by the limited 1963 data and second in the other two years as well as in the three-year total. Aspen became more palatable as the summer progressed and leaves knocked down by logging or blown from mature trees by wind were always more palatable than young reproduction. Mountain dandelion (*Agoseris aurantiaca*), June grass, sweet clover (*Melilotus*), white fir, buttercup (*Ranunculus*), daisy (*Erigeron*), and a few other forbs were important. Some plants were taken readily and extensively for short periods; for example, pine and white fir leaders were browsed very early in June and prostrate knotweed (*Polygonum aviculare*) was taken in early July when a mat of this plant appeared in disturbed areas after summer rains. There was little apparent difference in choice of feed by bucks and does or between different ages of animals. Any differences noted could be explained by the sites selected by the does during the fawning period. Not all of the plants recorded as being eaten by deer in this summer period appear in Table 1. Some use was seen on 16 different forbs, 8 grasses and 8 trees or shrubs in 1964.

TABLE 1. TOTAL FEEDING MINUTES ON INDIVIDUAL PLANT SPECIES 1962 TO 1964. JUNE AND JULY DATA.

Grasses	1962	1963	1964	3 year total
Koeleria cristata	19.23	2.30	2.65	24.18
Dactylis glomerata	46.09	2.55	49.95	98.59
Festuca ovina	.20	—	2.20	2.40
Poa			0.40	.40
Bromus inermis	1.30		6.25	7.55
Agropyron	—	—	5.80	5.80
Phleum pratense	—	.60	1.20	1.80
Carex	—	—	0.30	.30
Forbs				
Melilotus officinalis	3.15	.60	12.90	16.65
Trifolium	11.40			11.40
Taraxacum	4.55	.40	26.00	30.95
Agoseris aurantiaca	3.15	2.20	22.70	28.05
Erigeron flagellaris	—	—	13.00	13.00
Ranunculus cymbalaria	—	—	8.85	8.85
Polygonum aviculare	—	2.60	13.40	16.00
Pseudocymopterus montanus	3.40	1.30	10.40	15.10
Phacellia magellanica	1.15	4.00	1.20	6.35
Arenaria saxosa	3.40	—	.30	3.70
Thlaspi Fendleri	1.12			1.12
Trees and shrubs				
Populus tremuloides	31.47	13.75	37.99	83.21
Abies concolor	8.36	3.34	4.90	16.60
Pseudotsuga taxifolia	1.10	—	.30	1.40
Picea Engelmanni, P. pungens	.20	.40	T	.60
Rosa neomexicana	1.40	—	—	1.40
Symphoricarpos	2.40	.68	—	3.08
Pinus ponderosa	—	.10	.65	.75
Robinia Neomexicana	—	2.20		2.20
Ceanothus Fendleri	—	—	2.03	2.03
Other				
Salt or clay licks	24.05	—	11.30	35.35
Total time (minutes)	167.12	37.02	234.67	438.81

Deer used the edges of the reseeded meadows and they were most often observed in either the higher ends of the meadows or in narrow necks near dense cover. Deer use was increasing in 1964 in the middle of the summer range portion of the burn due, at least partially, to the added cover of the aspen regrowth. Aspen density on this eastern side of the plateau had not been reduced by tent caterpillar but growth density of aspen was reduced on much of the logged areas of the western side by heavy tent caterpillar attack in 1963 and 1964. Caterpillar control programs were then underway to stop this infestation. The deer also used the edges of the blowdown but by 1964 deer use had begun to decline in the blowdown area and fewer deer were seen feeding in the logged mixed conifer and ponderosa pine as it had been some time since the areas under study had been revegetated. This was due to a change in plant composition in the logged areas and in the blowdown which included a greater amount of sedge in the ground cover. Reduced rainfall in 1963 also caused a decline in the amount of plant cover but density again increased after better winter and spring moisture fell in 1964.

The line intercept transects verified the differences in plant density between areas. Total ground cover was fairly low in the logged sites particularly in ponderosa pine after selective cutting. It was highest (42.4% in 1964) in the burned mixed conifer and continually increased over the three summers. Late summer transect readings would perhaps show an even higher plant density. The lowest density was recorded on an area in ponderosa pine measured after the logging roads were established but before the area had been cut (3.8%). The percent of low ground cover by sites is shown in Table 2 and the percent of deer and cattle use at the time the transects were read is also given. Very little use was recorded because these transects were read relatively early in the grazing season, and considerable area is available to the deer at their present herd density.

The physical condition of the deer could be judged, to a degree by their appearance. For example, some of the deer seen in June of 1964 on the summer range had either ribs or hip bones showing and many had rough coats. Practically all of the yearlings had rough, unshed pelage at this time. By July 1 all of the deer were in good physical appearance with the exception of an occasional doe with a new fawn. There was a visible difference in general deer condition or their rate of return to good physical appearance between different areas of summer range. Deer who stayed in overused meadows or undisturbed mixed conifer type seemed to be slower in both shedding and fattening when compared with deer habitually using seeded meadows, logged areas or the burn.

DISCUSSION

The extensive use by deer of the planted grasses on this summer range may be surprising to some. Hill (1956) states that mule deer

TABLE 2. PERCENT OF GROUND COVER ON TRANSECTS AND PERCENT OF USE BY DEER AND BY CATTLE.

	Logged Ponderosa Pine			Logged Mixed Conifer			Cleared Mixed Conifer			Burn Mixed Conifer		
	1962	1963	1964	1962	1963	1964	1962	1963	1964	1962	1963	1964
Total percent of low ground cover	8.0	4.4	12.6	6.4	11.4	16.7	32.0	Bull-dozed	23.5	21.2	30.7	42.4
Percent of vegetation available used by deer	.1	1.3	1.6	0.8	0.8	1.1	6.5	Bull-dozed	3.1	2.6	5.3	3.8
Cattle use of vegetation available	1.5	1.2	.5	T	T	T	0	Bull-dozed	0	0	0	0

TABLE 3. PERCENT OF GROUND COVERED BY GRASS, FORBS, TREES, AND SHRUBS WITHIN REACH OF DEER ON TRANSECTS.

	Logged Ponderosa Pine			Logged Mixed Conifer			Cleared Mixed Conifer			Burn Mixed Conifer		
	1962	1963	1964	1962	1963	1964	1962	1963	1964	1962	1963	1964
Grasses	4.5	3.0	9.1	3.3	3.2	6.7	21.3	—	18.8	12.8	15.1	25.4
Forbs	2.1	.7	2.7	.2	.6	1.4	7.8	—	3.2	2.0	8.2	6.7
Trees and Shrubs	1.4	.7	.8	2.9	8.5	5.1	2.9	—	1.5	6.4	7.4	10.3
Total	8.0	4.4	12.6	6.4	11.4	16.7	32.0	—	23.5	21.2	30.7	42.4

normally consume less than 10 percent grass in their summer diet. He points out, however, the difficulty of specific identification of herbaceous species in stomach analyses. This and other mule deer food studies in various parts of the West point out the variability of the diet but they indicate a major use of grasses only in the spring. Dixon (1934), however, in an early study of the food of mule deer in Yosemite emphasized the use of fresh green grass. He was also perhaps the first to use deer feeding minutes as a measure of importance of various forages. Rasmussen's (1941) study of diet of deer on the Kaibab summer ranges was done during a period of range depletion shortly after the first irruption. He found that deer at that time consumed "extremely little grass . . . even with the paucity of preferred foods." *Native* grasses were taken very sparingly in the current study but the lush growth of planted grasses were taken readily even though these may be but a temporary member of the plant community. Planted grasses and legumes and the temporary weeds associated with them were selected by the deer and formed an important part of their diet in the summer.

The total deer food supply has been increased by the creation of large areas of disturbed soil. As previously mentioned, only within recent years has fire, wind, logging and meadowland improvement covered major amounts of summer range. Seeding of any and all disturbed sites was and still is the firm policy of the Kaibab Forest supervisor. The objectives are to give temporary protection from erosion, to provide a nurse crop for tree and shrub reproduction, and to increase the food supply for deer.

It should be mentioned that a large percentage of the plantings were successful. Soil is fertile, the manpower and equipment are adequate, and suitable combinations of grasses and legumes are used for each different habitat type. Experience and the information attained from plot trials are now paying off in good results from most of the seeding efforts.

In the arid West, adequate food is too frequently controlled by seasonal rainfall. Planted cool-season grasses which depend upon deep-soaked winter precipitation should be more dependable than ephemeral summer annuals dependent upon early summer precipitation. Game managers are becoming increasingly aware of the influence of seasonal precipitation on fawn production and survival. Russo (1964) found the summer months here to be critical and some degree of fawn loss to be expected if inadequate food resulted from lack of rainfall during the summer lactation period. Julander, *et al.* (1961) recorded a 40 percent fawn mortality on poor mule deer range in Utah in contrast to a 16 percent loss on good range in

Idaho. Swank (1958) found the nutritional plane in summer and fall preceding the rut to be a major factor controlling ovulation and the number of fawns developed per doe. He recorded the results of the dry summer plus excess deer numbers on the Kaibab in 1954 in buck weights averaging 20 pounds less than any year of record, in a substantial reduction in rutting fervor, and finally in a fawn crop lowest on record (28 fawns per 100 does). Summer foods, therefore, have considerable influence on mule deer reproduction and survival of fawns. White-tailed deer reproduction is also influenced by nutritional plane during this season (Verme, 1963), but most whitetail deer range lies in areas receiving adequate or at least more consistent precipitation. A lack of expected seasonal rainfall can be as detrimental to deer in the warm Southwest as a severe winter is to northern whitetails. Excess deer numbers lead to increased losses in either case. The need for increasing summer carrying capacity on mule deer range is obvious.

The management history of the Kaibab herd is not essentially different from that of many other western deer herds but its problems have been well documented and publicized. There are no great differences in the results of logging, fire, and habitat improvements done here in comparison with other areas. There is one financial difference between the Kaibab and most other game ranges on publicly owned and federally managed lands. Perhaps another lesson can be learned from the Kaibab because of this difference. Funds have been provided by the deer hunter which help pay for management of deer habitat. The Kaibab is a working example of what can be done with a fee collected for recreational use of National Forest land. This special fund has been collected for many years under the original Kaibab agreement between the Arizona Game and Fish Commission and the Kaibab National Forest, (Russo, 1964). Each hunter currently pays a $5.00 fee as he checks into the area to hunt. This fee is in addition to charges for his hunting license and his deer tag and the total amount collected is jointly administered by Arizona and the Forest Service. Improvement projects are large enough to have some effect and are not merely trials to see what could be done if funds were available. Necessary equipment, manpower, and materials for large scale projects as well as early experimental trials can be financed. The habitat management measures discussed are expensive and range from $5.00 per acre cost of broadcast seeding of disturbed soil in timber sails to $12.00 per acre for plowing and drilling meadows (Hodgin, 1964). The multiple use policy of the Forest Service means an endeavor to utilize management procedures in ways to benefit wildlife on logging operations or during most other resource management functions. Harvest of wildlife, however, should help pay for improvements for wildlife just as the payments for sawlogs should pay for erosion control, slash disposal and thinnings. Instead of depending upon timber sales, the Kaibab hunt funds can finance much of the project here evaluated as well as build hunter access roads, develop new water sources or finance other equally worthwhile projects.

As pointed out by Russo (1964), the administration of this area has involved several agencies and many factions have felt the need to introduce their ideas and convictions. Coordination of efforts has, however, improved considerably since the late 1920's when Arizona game wardens arrested government hunters for their attempts to reduce the overpopulation; a case finally decided in favor of the Forest Service by the Supreme Court (Russo, 1964). Today the coordinated, intensive management has resulted in both an improving deer herd and an improving deer range. The Kaibab herd's reputation indicates, however, a need for continued close herd control, a well-informed public, and adequate habitat management.

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DISCUSSION

DISCUSSION LEADER MOSBY: The Kaibab, as you are all aware, has been in the eyes of the wildlife conservationists for many years. I am sure there may be questions about the present status of this herd and its management.

MR. MCCLELLAN (American Forest Products Industries): Is the surplus of deer being harvested or what about their disposal?

DR. HUNGERFORD: I am not too competent to answer that. I am in the middle, not in the Forest Service and not in the game department. I would say from my own observation that it is well-managed today. There is always danger, but at the present time I think the herd is under control.

MR. MCCLELLAN: Has there been any discing in your reseeded stands to increase aspen production?

DR. HUNGERFORD: No, I don't believe so. There has been some in the past. Most of the discing and seeding is in the meadows where they are rehabilitating badly depleted meadows. That may be what the Forest Service has in mind for the future, the rehabilitation and reseeding of some of the aspen sites. They attempted to find a market for aspen, but the market is too far away.

DR. KEN DIEM (University of Wyoming): Chuck, there is something that has always bothered people when you evaluate grass. Deer and elk both use grass in the spring of the year, and most of the range managers measure it in the fall. Do you know of anyone who measures the importance of grass in the light of this seasonal discrepancy to obtain the relative value of the spring grass to the fall grass?

DR. HUNGERFORD: That is a tough one, Ken. Would you care to comment on that?

DR. DIEM: This is a question I have been asking in several meetings. We had the same problem with elk in the mountains, and I sometimes wonder how you can get very much importance of a grass range in the summer area when no one knows what the nutritive value is. We measure its productivity two months after the animal is using it.

DR. HUNGERFORD: I think one answer might be a continued measure of transects or a process to find out what proportion of the deer's diet is made up of summer grass. And again, we might need the nutritive analysis of different types during the year. But just as the deer in this area will pick the mature aspen leaf over the younger reproduction, I think there is a certain selection of the grass foods in the same way. They will pick the grasses that either have a higher sugar content or those that at least to them are preferential to other grasses. I think there is a definite selection of certain types of grasses.

DR. DIEM: I think this is true and that our range management people should try to figure out a standardized technique to measure forage production areas that have nothing showing and then grow to profusion. We have very little information on this. I think it is long overdue that we approach this problem from different angles as far as season and techniques are concerned.

MR. ELLIOTT BARKER (New Mexico Wildlife Conservation Association): On two different occasions I have had the opportunity to make an inspection of the Kaibab area and am fairly familiar with it. It has a nationwide reputation I think for turning out trophy deer. I wonder under this game management program reseeding that you are carrying out, if the trophy type heads are still being produced in comparable numbers to what they were a few years ago?

DR. HUNGERFORD: I see Dr. Swank very close to you and I wonder if I couldn't give that question to him.

DR. SWANK: The Kaibab is not producing the trophy bucks in horn size that it once did. We are caught between keeping the herd in balance with the range or producing trophy bucks. As far as the weight is concerned, the weight of bucks has dropped below 126 pounds. The average weight of 3-year-old bucks this last year was 185 or 190 pounds. So for those people who are willing to trek back into those few areas that are left that are not readily accessible to hunters by access roads which are necessary to control the herd, there are still tremendous bucks both in horn size and in weight.

MR. BARKER: Thank you. I would like to comment for just a few words on the question about the nutrients of the grass used by deer and so on. In my observations the green grass used by deer and antelope in the spring is exceedingly important to them just as it is to cattle and sheep, to provide milk for the young as they are born.

I have found that if deer and antelope do not have green feed, and that includes browse and grass, but principally grass in the spring, the females do not produce milk enough to sustain the young. Often an antelope will give birth to her young and if she doesn't have milk for it, walk off like the sheep does and leave it to starve. So I do think the grass consumption, while maybe in the year around picture is not very great, is highly important in the spring of the year.

When I was last on the Kaibab it seemed to us that the encroachment of young pine and spruce around the edges of the park, continually reducing the size of the park, was having what appeared to be an adverse effect on the range generally. Certainly it was effecting a change by making more forested area and cutting out the openings. Is that continuing or is something being done to retard that encroachment?

DR. HUNGERFORD: I think part of that, Mr. Barker, was started with the very early cattle use. But on the other hand, this is one of the things that the cooperative funds are being used for, to rehabilitate these meadows, to clear the young spruce and pine encroaching on the edges of the meadows, and to reseed the areas. About 2900 acres so far have been improved in that manner.

MR. BARKER: We have had that problem in New Mexico with young coniferous growth coming in, and in many areas crowding out the park lands and bringing about an imbalance of park and timber.

FEEDING COACTIONS BETWEEN SNOWSHOE HARES AND WHITE-TAILED DEER IN NORTHERN MICHIGAN[1]

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Recent studies of food preferences of confined snowshoe hares (*Lepus americanus*) showed that hares are potential competitors with white-tailed deer (*Odocoileus virginianus*) for available food because of (1) a preference for many plant species also palatable to deer, and (2) a high daily rate of food intake (Bookhout, 1963). A pronounced utilization of deer foods by hares would materially decrease the number of deer a winter habitat could support and might contribute to starvation losses during severe winters. A three-year study was initiated in 1959 to investigate the winter feeding coactions between deer and hares in the Upper Peninsula of Michigan. This paper presents the results of that study.

In the northern parts of their range, white-tailed deer commonly spend winters in low, coniferous areas which afford them protection from low temperatures, deep snow, and associated weather conditions. The period and length of time deer are yarded vary with intensity and duration of severe weather conditions. In most of the Upper Peninsula they normally are in the yards by the middle of December and do not move out until about the first of April. Length of the yarding period is therefore at least 100 days in most years. During this time, deer may exert extreme browsing pressure on the vegetation

[1]A contribution of Pittman-Robertson Federal Aid in Wildlife Restoration Project W-70-R.

within and proximal to the yarding area. Because these yards are used year after year, food availability has become a serious problem, and in severe winters deer losses from starvation often are sizeable.

In northern Michigan snowshoe hares commonly are associated with lowland coniferous areas, and there is no evidence to indicate any widespread seasonal movements to and from these areas (Bookhout, 1963) as is the case with deer. Therefore, hares may utilize food reserves in yards during the entire year, whereas deer feed there only during the normal yarding period.

DESCRIPTION OF STUDY AREA

A deer yard located approximately three miles northeast of Shingleton, Michigan, was selected for study. The area had sustained a substantial winter deer population for many years. A rectangular area of 627 acres, comprising most of section 22, T 46 N, R 17 W, Alger County, was chosen as the intensive study area. Some of the heaviest winter deer concentrations occurred on this section.

Six distinct forest cover types were present on the study area, and four were of sufficient acreage to permit an appraisal of their use by hares and deer (Fig. 1). A description of these types follows.

Swamp conifers (357 acres). White cedar (*Thuja occidentalis*)[2] predominated, and species present in lesser quantity were black spruce (*Picea mariana*), balsam fir (*Abies balsamea*), tamarack (*Larix laricina*), speckled alder (*Alnus rugosa*), winterberry (*Ilex verticillata*), and willows (*Salix* spp.) Size classes and stocking of overstory species varied considerably in this type.

Northern hardwoods (113 acres). Moderately-stocked, second-growth sugar maple (*Acer saccharum*), sapling and pole-size, predominated in this type. Other overstory species were American elm (*Ulmus americana*), ironwood (*Ostrya virginiana*), yellow birch (*Betula alleghaniensis*), and basswood (*Tilia americana*). The understory was largely sugar maple reproduction less than one foot in height.

Alder swamp (58 acres). Speckled alder, which decidedly predominated, winterberry, and willows were densely stocked, and white cedar, black spruce, and balsam fir were of occasional occurrence.

Mixed swamp hardwoods and conifers (47 acres). Cedar and red maple (*Acer rubrum*) were moderately stocked overstory species, and black and white (*Picea glauca*) spruce, balsam fir, sugar maple, black ash (*Fraxinus nigra*), and hemlock (*Tsuga canadensis*) were present in lesser quantity. Sugar and red maples, mountain maple

[2]Scientific names are according to Fernald (1950).

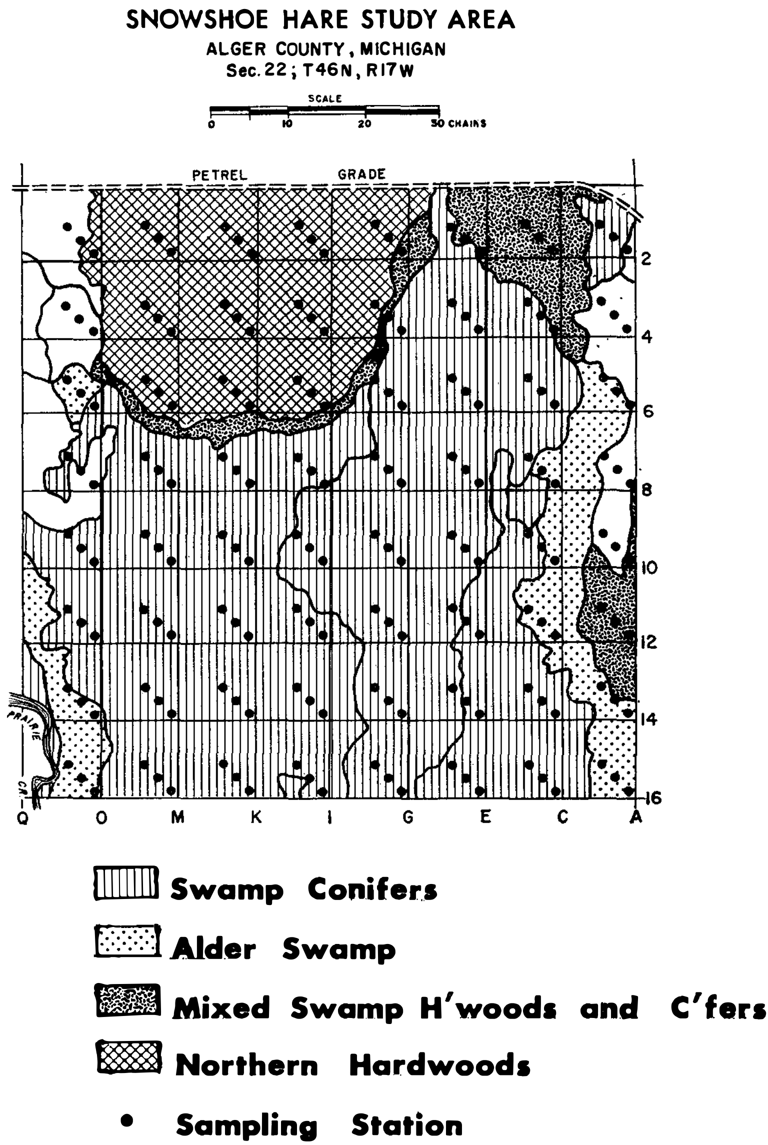

Figure 1. Major forest cover types on the study area.

(*Acer spicatum*), and beaked hazel (*Corylus cornuta*) were common understory species.

MATERIALS AND METHODS

Establishment of Sampling Stations

North-south and east-west lines were established at 10-chain intervals throughout the study area. Four- to five-inch cedar posts, six feet in height, were set wherever the lines intersected, establishing a total of 64 stations.

To locate browse analysis and pellet survey plots, a series of stakes was placed in a northwest direction, at a distance of one, three, and five chains, from each station post (Fig. 1). Sixty-four courses of three plots each, or 192 plots, were used for browse analyses and pellet surveys.

In addition to the cedar posts, stakes were established at five-chain intervals along and between the north-south and east-west lines, so that a grid pattern of 268 stations was present throughout the area. These served as trapping sites for hares.

Estimates of Populations

Numbers of deer wintering on the study area were determined for the winters of 1959-60 and 1960-61 by pellet group counts (Eberhardt and Van Etten, 1956). This method was believed the best available for obtaining a population estimate not based on subjective impressions. Because of the character of the vegetation in the coniferous swamp portion of the area, efficiency in locating all pellet groups might have been seriously impaired utilizing the 1/50-acre plot size suggested by Eberhardt and Van Etten (1956). To overcome this problem, one-milacre plots were used. Pellet group counts were made in the spring, in conjunction with the browse analyses.

Hares were live-trapped 11 days each month for a 16-month period, December, 1959, through March, 1961. All hares were ear-tagged upon initial capture and released. Monthly population estimates were made according to the Lincoln Index (Davis, 1963).

Surveys of Browsing

A survey method modified from that described by Passmore and Hepburn (1955) was used to record browsing by deer and hares. A circular one-milacre plot (radius, 3.7 ft.) was the sample unit. A length of plastic clothesline rope was looped around the plot stake and stretched tightly to delineate the plot boundary. Any stem at least halfway within the circular plot was considered to be wholly within the plot, and all twigs arising from that stem were counted in the plot. Twigs falling within the plot which originated from stems rooted outside the plot were considered outside the plot. Only twigs one inch or more in length were counted, and only browsing of the current year was included in the surveys. Total counts, rather than estimates, were taken of twigs present and removed by browsing.

All vegetation less than one foot in height was considered unavailable to deer; by the time they entered the yard, this vegetation was beneath the snow. The maximum height to which hares and deer could compete for food was believed to be about six feet. Thus, all twigs in the sample plots between a height of one and six feet were counted. Analyses were made in the spring, between the times of disappearance of snow and leaf-out (mid-May to early June).

RESULTS

Numbers of Deer

The computed numbers of deer per square mile on the area during the two winters of study were 134±42,[3] or one deer per 4.7 acres, in 1959-60 and 167±39, or one deer per 3.8 acres, in 1960-61. Hunting on the study area and vicinity probably did not materially affect deer populations in either year, although in both 1959 and 1960 the area was included in a special hunting area in which shooting of antlerless deer was permitted.

Numbers of Hares

During the winter of 1959-60, when the hare population in Michigan was at the high of the periodic cycle, the mean monthly (December-March) population was 99±25, or approximately one hare per 6.3 acres. Productivity of hares on the study area was very low during the summer of 1960, and no increase in autumn populations was evident. The mean monthly population of hares during the winter (December-February) of 1960-61 was 31±6, or one hare per 20.2 acres. The population during the second winter was nearly 70 percent below that of the winter of 1959-60. A pronounced decrease also was evident throughout Michigan and reflected the general downward trend in the hare population from the high of 1959-60.

Hunting was of no consequence in reducing the population of hares on the study area. In the entire period of study, no hare hunter was ever observed on the area or its vicinity.

Availability of Browse

The greatest amount of available browse per acre was present in

[3]Standard error of mean x 2.

alder swamp in both winters, where more than 550,000 twigs of all species were available (Table 1). Shrubs comprised a major portion of the total number of basal stems present in this type. Bartlett (1950) remarked that shrubs, although relatively inconspicuous, collectively produce enormous amounts of winter food. The swamp conifer type provided only about half as much available browse per acre as did the alder swamp type the first winter and 40 percent as much the second winter. In both years the mixed swamp hardwoods and conifers type provided only about 20 percent of the amount of browse available in the alder swamp type, and the northern hardwoods habitat approximately 12 to 15 percent.

TABLE 1. AVAILABILITY OF BROWSE IN THE MAJOR COVER TYPES.

Cover Type	Number of Available Twigs Per Acre		Percentage of Total Twigs in Type	
	1959–60	1960–61	1959–60	1960–61
Swamp Conifers	272,349	244,560	63.6	60.1
Alder Swamp	553,652	588,565	27.3	30.5
Mixed Swamp Hardwoods and Conifers	105,000	107,692	2.9	3.1
Northern Hardwoods	90,125	87,750	6.2	6.3
All	263,667	250,859	100.0	100.0

The proportion of major cover types on the area was an important factor in determining the ultimate food value of each type. In both winters the swamp conifers type (357 acres) provided more than 60 percent of all browse available on the area (Table 1). Alder swamp areas (58 acres) yielded approximately 30 percent both winters, the northern hardwoods area (113) 6 percent, and the mixed swamp hardwoods and conifers habitat (47) 3 percent.

Principal browse-producing species in the major cover types, in order of decreasing abundance, were as follows: swamp conifers—white cedar, speckled alder, black spruce, buckthorn (*Rhamnus* spp.) balsam fir, winterberry, willows, red osier dogwood (*Cornus stolonifera*), and Labrador tea (*Ledum groenlandicum*); alder swamp—white cedar, winterberry, speckled alder, balsam fir, black spruce, sweet gale (*Myrica gale*), and swamp birch (*Betula pumila*); mixed swamp hardwoods and conifers—balsam fir, sugar maple, beaked hazel, red maple, and white cedar; northern hardwoods—sugar maple and beaked hazel.

Browsing by Deer

On a per acre basis, the northern hardwoods type received the highest browsing pressure of all types in the first winter, when more than 29,000 twigs per acre were removed (Table 2). Alder swamp and mixed swamp hardwoods and conifers types sustained pressures approximately three-fourths and one-half as great, respectively. The swamp conifers type suffered the least browsing pressure on a per acre basis, about a third of the northern hardwoods type. The following winter, extensive use of the alder swamp type was reflected by the high number of twigs removed per acre (40,753). Browse removal from the northern hardwoods type was only 40 percent as great. Twigs per acre removed from the swamp conifers type increased somewhat over the previous winter while those from the mixed swamp hardwoods and conifers type decreased 50 percent.

The ultimate value of the cover types in the provision of browse was dependent upon the total acreage of each type on the study area. Thus, swamp conifers furnished 40 to 47 percent of the total number of twigs removed by deer in the first and second winters, respectively (Table 2). Use of the northern hardwoods area, greater in the first winter than in the second, was confined to the immediate periphery of the swamp conifers type. In the alder swamp type, the amount of browse removed was 70 percent greater in the second winter than in the first. Amounts of browse removed from these types reflected the difference in range use in a severe and a mild winter. In both years the mixed swamp hardwoods and conifers type provided a very small portion of the total twigs removed by deer.

Deer utilized 5.8 and 6.8 percent of the total browse available in the first and second winters of study, respectively. In the second winter the amount of available browse declined nearly 5 percent over that of the previous winter, and deer use increased by 11 percent (Table 2). These data suggested that the carrying capacity of the yard was declining steadily. The amount of browse present on the area did not in itself indicate the range was deteriorating, but Beals *et al.* (1960) stated that range which is deteriorating rapidly may nevertheless provide abundant food. The decline was noticeable during the period of study, however, in that portion of the swamp conifers adjacent to the alder swamp.

Most plant species received some browsing pressure by deer. The greatest use was sustained by only a few plant species, however, and varied with cover type, relative availability of food items, and mobility of the yarded deer. Principal food species eaten were white cedar, sugar maple, willows, beaked hazel, swamp birch, speckled alder, and winterberry. Trembling aspen (*Populus tremuloides*) and black ash, low in availability, were fed on heavily wherever they occurred.

In both years the same plant species provided most of the total browse removed by deer, but intensity of use of some species differed between years. White cedar and sugar maple together received 24 percent less use in 1960-61 than in 1959-60, and willow, swamp birch, speckled alder, and winterberry together sustained nearly 22 percent greater total use in the second winter than in the first. It seemed likely that this second group of foods was more heavily utilized the second winter simply because the milder weather permitted deer to frequent the more open portions of the study area throughout the yarding period.

The important species of browse removed by deer in the various cover types were as follows: swamp conifers—white cedar and speckled alder; alder swamp—white cedar, winterberry, balsam fir, swamp birch, red osier dogwood, and willows; mixed swamp hardwoods and conifers—red maple, sugar maple, mountain maple, and beaked hazel; northern hardwoods—sugar maple and beaked hazel.

Browsing by Hares

The swamp conifers type received highest browsing pressure in the winter of 1959-60 in terms of the number of twigs removed per acre, and the number taken from the alder swamp type was nearly as great (Table 2). The amount removed per acre in the mixed swamp hardwoods and conifers type was approximately half that taken from the alder swamp type, and a negligible portion was removed from the northern hardwoods type. In the winter of 1960-61, browse removed per acre was highest in the alder swamp type and approximately 40 to 50 percent less in the mixed swamp hardwoods and conifers type and swamp conifers type, respectively. No browsing occurred in northern hardwoods.

An analysis of the total acreage of each major cover type revealed the actual value to hares of each type. Swamp conifers provided 79 percent of all browse removed from the study area in the first winter and 65 percent the second winter (Table 2). Considerably less browsing occurred in alder swamp, and use of the remaining two types was negligible.

The overall decrease in browsing pressure in 1960-61 from the previous winter was not uniform over the entire area and resulted largely from a decrease in browse removal from the swamp conifers type. Portions of this type appeared to be the most favorable habitat for hares, and in a period of declining hare numbers the type providing best food and cover could be expected to support the greatest number of hares. The considerable use of the alder swamp type as a food source was not expected because of a serious lack of ground cover in that type. Moreover, trapping returns did

TABLE 2. BROWSING BY DEER AND HARES IN THE MAJOR COVER TYPES.

Cover Type	Number of Twigs Browsed Per Acre		Percentage of Total Browsing in Type		Percentage of Twigs Browsed	
	DEER	HARES	DEER	HARES	DEER	HARES
1959–1960						
Swamp Conifers	10,073	3,725	40.4	79.0	3.7	1.4
Alder Swamp	21,739	3,391	18.4	15.2	3.9	0.6
Mixed Swamp Hardwoods and Conifers	14,384	1,615	6.9	4.1	13.7	1.5
Northern Hardwoods	29,156	281	34.3	1.7	32.4	0.3
All	15,356	2,904	100.0	100.0	5.8	1.1
1960–1961						
Swamp Conifers	13,055	1,165	47.1	65.4	5.3	0.5
Alder Swamp	40,753	2,130	31.1	25.3	6.9	0.4
Mixed Swamp Hardwoods and Conifers	7,385	1,385	3.2	9.3	6.9	1.3
Northern Hardwoods	17,594	0	18.6	0.0	20.1	0.0
All	17,062	1,096	100.0	100.0	6.8	0.4

not indicate that hare activity was particularly great there during the second winter.

In both years hares removed a very small segment of the total browse available. Only 1.1 percent was taken in the winter of 1959-60, and 0.4 percent the following winter (Table 2). Total browse removed from the combined acreages of the four types decreased from 2,904 stems per acre in 1959-60 to 1,096 in 1960-61, a decrease of approximately 62 percent. This agreed closely with the population decline of hares of nearly 70 percent between the first and second winters. The small amount of total available browse consumed by hares indicated they had an almost negligible effect on the food supply in the yard. Evidence of browsing was never conspicuous, and it was necessary to examine carefully each basal stem to find browsed twigs. Pronounced "barking" of stems was observed on fewer than a dozen occasions.

In general, hares used the same few plant species as a food source in both years of study. Use varied with cover type, however, and some differences were noticeable between the first and second years of study. The most important browse species were white cedar, speckled alder, red maple, willows, juneberry (*Amelanchier* spp.), swamp birch, and beaked hazel.

Almost two-thirds of all twigs browsed by hares in the winter of 1959-60 were provided by white cedar, speckled alder, willows, and red maple. Swamp birch and beaked hazel together accounted for an additional 11 percent. The most important species in the second winter, in terms of total precentage of use, were the same above species except that juneberry replaced swamp birch.

Comparison of Browsing by Deer and Hares

Of 39 plant species available in the two winters of study, 29 were browsed by deer, 23 by hares, and 19 by both animals. However, few of the 19 species occurred in quantity, and few were taken in quantity by both deer and hares (Table 3). Because combined browsing pressure was greatest in the swamp conifers and alder swamp types (Table 2), these types were further analyzed to determine deer and hare use of the plant species present. Combined browsing in the mixed swamp hardwoods and conifers and northern hardwoods types did not appear to be important.

TABLE 3. BROWSING BY DEER AND HARES OF IMPORTANT PLANT SPECIES IN THE MAJOR COVER TYPES

Species[1]	Number of Available Twigs per Acre		Percentage of Twigs Browsed in 1959–60		Percentage of Twigs Browsed in 1960–61	
	1959–60	1960–61	DEER	HARES	DEER	HARES
			Swamp Conifers			
White Cedar	198,807	168,284	3.8	0.7	4.0	0.1
Speckled Alder	23,101	25,798	3.9	3.8	9.5	1.0
Balsam Fir	4,349	4,817	—	—	9.3	1.3
Willows	3,138	3,229	7.0	15.1	36.8	9.1
			Alder Swamp			
White Cedar	112,957	110,739	5.4	—	3.5	0.9
Speckled Alder	103,783	105,217	0.6	0.8	2.5	0.3
Balsam Fir	67,391	70,826	2.3	—	5.0	0.4
Swamp Birch	24,087	31,348	23.3	1.4	26.4	—
Buckthorn	15,957	15,870	1.1	2.7	1.1	0.3
Willows	8,739	9,783	13.9	3.1	26.7	—

[1] Includes only those species browsed by both deer and hares and comprising 1.0 percent or more of the total available twigs.

Twenty-seven plant species occured in the swamp conifers type; 22 were browsed by deer, 18 by hares, and 15 by both animals. Only four of the 15 species constituted more than one percent each of the total twigs present, however (Table 3). White cedar was present in greatest quantity, but no more than 4 percent of the twigs available were browsed by deer, no more than 0.7 percent by hares. Combined browsing of speckled alder removed 7.7 to 10.5 percent of available twigs in the two winters. Deer and hares exerted almost identical browsing pressure in the first winter, but deer browsed a far greater amount in the second winter. A large portion of available willow twigs was removed in both winters, although deer browsed two to four times more twigs than did hares.

In the alder swamp type, deer browsed 17 of 27 plant species, hares 14, and both animals 11. Six of the 11 species comprised more than one percent of the available twigs, and of these deer made greatest use of swamp birch, willows, and white cedar (Table 3). None of these species was heavily browsed by hares, although willows received greatest use. In both years combined browsing removed less that 5.5 percent of the available cedar twigs.

In summary, an analysis of deer and hare browsing on plant species in individual cover types showed that competition was not significant for any single food item available in quantity. In nearly every instance deer removed a greater portion of twigs than did hares.

DISCUSSION

The importance to both deer and hares of individual plant species is dependent upon two factors: (1) the relative availability of the plant species, and (2) the total amount browsed by both animals. Limited availability obviously lessens the importance of plant species. Competition becomes significant only when a substantial portion of available twigs is removed by combined browsing. White cedar is a case in point. It was unquestionably the most important deer food on the study area and it appeared to be the most important food for hares as well. However, combined browsing removed only 4.0 to 4.5 percent of available twigs in the first and second winters, respectively, and deer removed a substantially greater portion than did hares. These facts indicate that there was no apparent competition for white cedar; nor did deer and hares compete for other species present in quantity, even though the percentage of twigs removed from a particular species may have comprised a considerable segment of the total amount removed by either deer or hares.

The principal reason for absence of appreciable competition appeared to be not so much the lack of palatability of individual foods to both animals but rather unequal browsing pressure exerted on the vegetation. No plant species was heavily browsed by both animals. In the winter of 1959-60, at the high of their periodic increase, hares removed only about 19 percent as much browse per acre as did deer and in the following year only about 6 percent as much. Even in the first year, the ratio of use was of no great consequence when the amount of browse present was taken into account. This was in direct opposition to results of the study by Vozeh and Cumming (1961). They concluded that "hares at the height of their cycle did more damage to the vegetation than did the moose" and that "only the highest populations of moose and deer do as much damage to the vegetation as do hares when their cycle is high."

These conclusions lead to two considerations of the present study: (1) Was the deer population on the study area as high as could be expected in a deer yard in the Upper Peninsula, and (2) how "high" was the hare population on the study area? Michigan Game Division biologists familiar with the area conceded that the deer population there was quite high; none could name any other yard which held an apparently higher density. Unfortunately, it is not possible to provide a complete answer to the second consideration. Kill records showed that the hare population in Michigan reached a peak in the 1959-60 winter (Heath, 1961), and it seems safe to assume that the population on the study area was at a maximum density at that time.

There remains the question of whether hare densities on the area were comparable with those in areas not supporting wintering deer herds. Dodds (1960) reported an inverse relationship between moose and hare populations in Newfoundland. Areas of high moose density showed low browsing pressure by hares, and the highest hare density was in an area of low moose density. If the same relationship were true for deer and hares, densities of hares could be expected to be lower on the study area than on non-yarding areas. Hare populations from non-yarding areas were not measured in the present study, and none was available for comparison.

The influence of weather on mobility of the yarded deer was clearly demonstrated in this study. The winter of 1959-60 was one of moderate severity, and deer were yarded for approximately 130 days. They were closely confined to the swamp conifers type and did not frequent the more open portions of the study area. The winter of 1960-61 was much less severe, and the deer were yarded for approximately 100 days. They moved freely in the yard and commonly used the more exposed portions. It appeared that a much greater amount of browse present was actually *available* to deer in the second winter because they were able to move to the plants in those areas offering little overstory cover. Distribution and movements of hares appeared to be similar in both winters.

The deer yard under study might have been ecologically unfavorable to peak numbers of hares. Although apparently there was no shortage of food, low coniferous cover was lacking in portions of all cover types. This might have prevented a greater population of hares on the area, for low coniferous cover is a basic requirement for habitation of an area by hares (Grange, 1932). Hares probably reach greater densities in younger conifer stands in which a greater amount of low vegetation is present. Dodds (1960) stated that use by hares of white birch was very much less in climax forests than in regenerating forests and that it reached its highest point in cut-over stands 20 to 25 years old. Developing forest stands probably are not most favorable for sustaining wintering deer, however, because of a lack of adequate overhead cover. By the time a conifer swamp reaches the stage of growth suitable for holding deer through the yarding period it is probably past the optimum stage for habitation by snowshoe hares.

Vozeh and Cumming (1961) believed there was more likelihood of hares reducing the food of moose significantly than of the reverse happening. Dodds (1960) believed that heavy browsing by moose might accelerate the reduction of browse species available to hares, and this suggested that the moose would survive at the expense of the hares. Olsen (1957) presented data which strongly suggested that a decline in numbers of hares in one area of the Lower Peninsula of Michigan resulted from a lack of food and cover brought about by an overpopulation of deer. In the present study, it was apparent that deer exerted by far the greater browsing pressure and that they were the dominant cause of browse removal. In all likelihood, it is the hare population which ultimately will suffer as a result of reduced food and cover caused by overbrowsing by deer.

SUMMARY

Feeding coactions between white-tailed deer and snowshoe hares were studied during two winters to determine the extent to which the animals competed for food. The investigation was made in a portion of a long-used deer yard. Approximately 134 deer were present in the 1959-60 winter and 167 in the 1960-61 winter. Estimated hare populations were 99, at the high of the cycle, and 31, after the cyclic decline had begun, for the same periods, respectively. Analyses of browsing showed that deer removed 5.8 to 6.8 percent of the total browse available in the first and second winters, respectively. At their cyclic high, hares removed about 19 percent as much browse as did deer on a per-acre basis. Overall, competition was not significant for any single food item available in quantity. For the entire study area, white cedar was the most heavily used species, but combined browsing removed only 4.0 to 4.5 percent of the available twigs in both winters. Hares appeared to play a decidedly minor role in the removal of browse from the deer yard under study.

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DISCUSSION

DISCUSSION LEADER MOSBY: Dr. Bookhout has presented a somewhat different approach to the problems that we have discussed up to now, in pointing out some of the coactions between game species competing essentially for the same plant material. I am sure that most of us here would agree that such coactions probably will command more of our attention in the future.

Are there questions you would like to direct to Dr. Bookhout?

E. M. LAITALA (Conservation Commission of Michigan): I know this question is in the minds of a lot of you as to the giraffe-necked hares that grow up there in the Upper Peninsula. I come from the spot where the snow fall measures 226 inches some years and that accounts for the hares being able to reach six feet up.

DR. ROBERT WEEDEN (Alaska Department of Fish and Game): I have made no studies of moose and snowshoe hares in Alaska, but however, just tramping around in the bush you can get some subjective impressions for what they are worth.

In Alaska, in the interior, both moose and snowshoe hare use willow to a very great extent and as you might expect, there are fewer species of the browse there for these animals to eat. They do concentrate to a great extent on a very few, perhaps three or four important ones. There we have snow fall that generally does not accumulate more than two feet on the ground even at the end of a normal winter. However, the willows are rather easily bent down by a moderate snowfall and you will find in the spring when the willows have sprung back to their normal position you will have two browse lines as a result of snowshoe hare activity, one at 2, 3, and 4 feet and another at 10, 12 and 15 feet. I think this is perhaps to be considered.

Also, besides the concentration of both the moose and the snowshoe hare on willow, you have a situation where I am sure that, if you measure the populations of both species at certain years, in certain years you will find that the snowshoe hare certainly comprise a greater proportion of the total biomass of the area than do the moose. I think you could probably make some rough calculations showing that the rabbits potentially could eat more willow than do the moose in areas where both exist together.

DR. DAVID KLEIN (Alaska Cooperative Wildlife Research Unit): I would like to add a comment to Dr. Weeden's comments on moose and snowshoe hare in Alaska. We have had a couple of areas close to the university under observation through a couple of years, at least through one snowshoe hare peak. In addition to Dr. Weeden's observations, moose frequently break down aspen and willows which have been browsed at the lower level by snowshoe hare. The moose will break down and take off a few of the larger shoots and then the snowshoe hare return and bark the entire portion that has been broken down and made available to them. This thus contributes to the amount of browse available to the snowshoe hare.

DR. ARCHIBALD COWAN (Michigan): I wonder if you could tell us to what extent the cedar portion of your swamp was used by deer as compared to hare? Some of this was an immature cedar type and was much more open than the other type. Was there a differential use of these two types and did your count of the available browse include these two types in the same way?

DR. BOOKHOUT: The count did take into account the use of both types, Arch. I might say there was no measurable difference in the amount of use by hares of the two areas.

However, I think there was a very definite difference in use by the deer. The first winter was quite severe and the deer were more closely confined to the larger, more mature portion of the swamp. They simply didn't get into the open areas to feed. The second winter they roamed pretty much at will over the entire area. I think we can say that there was a definite difference in actual availability between the two years. I think what we are actually reporting when we tally the browse in the spring is presence, not necessarily availability and this certainly was true with the deer. The deer had a much greater amount of browse actually available the second winter than the first because they were able to get to it.

MR. DAVID PATRICK (St. Regis Paper Co.): You said when you measured these usages was in the spring. Was this done after the yard was broken up?

DR. BOOKHOUT: Yes, this was necessarily done after the snow had melted from the yard so we were able to measure down all the way to the ground. As I say, we didn't measure the lower foot. But we had to wait until the floor of the swamp was clear. Also we had to do it before leaf out, otherwise we would have an almost impossible job of locating the winter browse. So it was done between late May and early June.

MR. PATRICK: Did you have a bias on your hardwood usage after the deer had left the yard area where you have such a preponderance of hardwood usage in the hardwood area?

DR. BOOKHOUT: Well actually the usage in the hardwood type was confined to the immediate periphery of the swamp. Actually, all the use by the deer was confined to the immediate periphery, perhaps three chains in from the swamp conifers type.

MR. PATRICK: The area of measurement was in the same area?

DR. BOOKHOUT: The area of measurement was the entire hardwood type.

BREEDING DENSITY, REPRODUCTIVE SUCCESS, AND MORTALITY OF ROCK PTARMIGAN AT EAGLE CREEK, CENTRAL ALASKA, FROM 1960 TO 1964[1]

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Although the rock ptarmigan (*Lagopus mutus*) sometimes exhibits large and rhythmic fluctuations in abundance (Gudmundsson, 1960), little is known about these numerical changes. For that reason, and because this circumpolar species is an important part of Alaska's upland game resource, the Alaska Department of Fish and Game began a 10-year study of rock ptarmigan in August, 1959. Research objectives are 1) to describe breeding biology, social behavior, movements, and habitat preferences; 2) to record changes in reproduction and death rates, and to relate these to observed population fluctuations; 3) to identify important causes or correlates of variations in recruitment and mortality. This paper summarizes findings related to the latter two objectives from May, 1960 to August, 1964.

THE STUDY AREA

The study area, 15 square miles of hilly land in the drainages of Eagle and Ptarmigan Creeks, flanks the Steese Highway 104 to 107 road miles northeast of Fairbanks. The area encompasses a wide variety of alpine and subalpine biotopes, and is continuous with a large area of similar habitat stretching westward and eastward 150 to 200 miles.

Elevations on the study area vary from 2600 to 4400 feet above sea level. The rounded ridges and hills are part of an eroded peneplain of Precambrian schist, interrupted by masses of granite, quartz diorite, and allied Mesozoic rocks. The area apparently was not glaciated in the Pleistocene.

The climate of the area is continental subarctic. Total annual precipitation is from 10 to 15 inches, with snow cover usually present from mid-September to mid-May. Summers are cooler than in large valleys to the north or south. Wind is an important meteorological and ecological factor, especially in autumn, late winter, and spring. Days from mid-June to mid-August generally are frost-free, but snow flurries and light frosts occur occasionally within that time. Early flowers bloom between 20 May and 30 May; leaves appear on shrubs beginning early in June.

Small stands of spruce (*Picea glauca*) occur on a few south-

[1]Contribution from Federal Aid in Wildlife Restoration Project W-6-R, Alaska Department of Fish and Game.

facing slopes between 2600 and 3300 feet. Otherwise, trees occur only in groups of a few dozen individuals along lower reaches of unmined streams, or as scattered, stunted individuals in the area below 4000 feet. Arctic-alpine tundra is the most widespread vegetation, grading at lower elevations to shrubby communities on mesic sites, and to treeless, tussocky vegetation ("muskeg") on moist, gentle slopes. Narrow bands of tall willows (*Salix* spp.) line the banks of streams below elevations of 3400 feet. Plant succession is slow, and changes occurring from 1960 to 1970 are not likely to noticeably affect the distribution or numbers of ptarmigan.

Three miles of mining roads give access to the area, no part of which is more than 2½ miles from the Steese Highway.

POPULATION ESTIMATES

Five population estimates were made annually at Eagle Creek: 1) territorial cocks in late May, 2) adult females present at the start of nesting, 3) chicks produced at hatching, 4) chicks surviving to early August, and 5) adults surviving to early August.

Intensive search of the study area late in May, at or just after the peak of courtship activities, provided a total count of adult males. From 20 to 70 percent of the ground was then free of snow each year. Male ptarmigan, still in white plumage, made themselves conspicuous by sitting on trees, knolls, large rocks, and bare ground, and by calling loudly during territorial displays. The area was covered in 6 or 7 days by two persons. At population densities encountered during this study, confusion of counts was minimal. I think the totals obtained were within 5 percent of the actual number of adult males. Replicate counts could not be made.

About one hen was seen for every three males counted in each spring census. Because this was probably less than half the number of females present, it was necessary to estimate the adult female segment by using a variety of data acquired in June and July. Elements of this composite estimate were 1) females seen in May, 2) hens found on nests, 3) hens found with chicks early in the brood season, 4) females found dead throughout May, June, and July. Individual marking of adult hens helped to make the total estimate possible.

The number of chicks hatching on the study area was calculated as the product of the number of hens present in spring, the percentage of successful nestings in the sample observed, and the average number of chicks produced in successful nests. From 12 to 36 nests were found each year, or about 16 to 28 percent of those probably present.

The number of chicks present just before the hunting season was estimated by multiplying the probable number of successful nestings by the average number of chicks per brood in daily counts made in July and early in August. Dogs were used to find broods and to locate chicks remaining (if any) after the family group flew off.

Estimates of total adult mortality in summer were obtained by recording all deaths observed throughout May-August. From 2 to 5 percent of the adults estimated to be present in spring were found dead in June and July. The death of some adults certainly went unnoticed, despite daily coverage of parts of the study area by one or two trained dogs and two biologists. I have decided to assume that August populations of adults were 90 percent of spring numbers.

TRAPPING, BANDING, MARKING

Most ptarmigan were caught in long-handled hoop nets made of tubular aluminum. Adult male ptarmigan were easy to find and catch during late May and the first 2 weeks of June. A few hens were captured after flushing from nests, but far more were caught when displaying to distract attention from their chicks. We caught almost 90 percent of the hens seen with chicks less than 3 weeks old. Chicks were caught in the hand-held nets. Hens without broods, and adult cocks after territorial displays had ceased, were hard to catch. We had some success in 1964 with a net strung between two 100-foot ropes, held by a man at each end. When flocks of molting, broodless adults were found, the net was unrolled and the two men walked rapidly up to the running birds.

Colored, butt end, aluminum bands purchased from National Band and Tag Company, Newport, Kentucky, were used in this study. The bands, listed as Catalogue no. 4-1242 (size 10), were stamped WRITE ADFG JUNEAU in addition to serial numbering. Chicks were big enough to band when about 3 weeks old. Bands placed on birds in 1961 were still clearly legible in 1964, although some enamel had chipped around the numbers and letters.

Banding mortality averaged 1.5 percent of the birds handled, and was confined mostly to chicks. Strangling and wing fractures were the main causes.

Adults were marked with felt-tipped, ink-cartridge pens. Red, yellow, green, and purple were the most satisfactory colors. One or two colors were applied to the wings in combinations that allowed individual identification. Most birds were marked in June and July, and molted the colored feathers in July or August. As it was necessary to identify individual birds only in the period from June to early August, the method described was quite satisfactory.

AGE DETERMINATION

Bergerud, Peters, and McGrath (1963) showed that the age of willow ptarmigan in spring can be determined by examining the outer remiges. First-year birds have a smaller pigmented area on the 8th primary (counting distally) than on the 9th; the reverse, or equal amounts on 8th and 9th primaries, characterize older birds. The method was tested with rock ptarmigan from central Alaska whose ages were known from banding records or from internal examination for the bursa of Fabricius, and correctly identified 95 of 99 first-year males (96 percent), 110 of 111 first-year females (99 percent), 51 of 52 older males (98 percent), 87 of 88 older females (99 percent).

Data on age ratios in the breeding populations of 1960, 1961, and 1962 (especially hens) are not as satisfactory as data from 1963 and 1964. Until 1963 I determined age from the presence or absence of pigment on the 9th primary (as proposed by Petrides, 1942). The method later was found to be inaccurate, particularly for hens (Weeden, 1961).

RESULTS

Breeding Densities and Age Composition in Spring

Spring counts revealed 88 males in 1960, 134 in 1961, 170 in 1962, 141 in 1963, and 109 in 1964. Slightly lower estimates of hens were obtained (75, 135, 155, 130, and 100 in the 5 years beginning in 1960). Densities of cocks varied from 5.9 to 11.3 per square mile.

The percentages of first-year ptarmigan in breeding populations from 1960 to 1964 were 1) males, 46, 65, 67, 67, 41; 2) females, 70, 69, 75, 72, 17. From 30 to 60 percent of adult males on the study area, and 50 to 70 percent of adult females, were caught each year.

There were significantly fewer yearlings among males than among females in 1960. The ratio of first-year to older males remained at about 2.0:1.0 from 1961 to 1963. In 1964 the ratio dropped sharply to 0.7:1.0. The age ratio among hens was about 2.6:1.0 for the first 4 years, then plummeted to 0.2:1.0 in 1964. (The true ratio of yearlings: older females in 1960, 1961, and 1962 might have been slightly lower than given above, because of inaccuracies in age determination mentioned earlier.)

Reproductive Performance

The important elements in reproductive performance were clutch size, nest and egg loss, hatchability, and survival of chicks to early August. Specimen collections close to the study area and field observations at Eagle Creek failed to uncover evidence that any female rock ptarmigan did not breed. If non-breeding did occur, it must have been very rare.

Clutch Size

The average number of eggs per nest varied from 8.2 to 6.5 (Table 1). Standard deviation and range were least in 1960 and 1964 and greatest in 1961. Average clutch size differed significantly from the peak size (8.2 in 1960) in 1962 ($P<0.05$), 1963 ($P<0.01$), and 1964 ($P<0.01$).

Nests of 29 hens 2 years old or older in 1963 and 1964 had a mean clutch size of 6.7; nests of 13 yearling hens averaged 6.3 eggs. The values are not significantly different. Whatever caused the depressed clutch size in 1963 and 1964 seemed to affect experienced and first-time breeders similarly. Age determinations among hens were not reliable enough in 1960-62 to make the same comparison.

Nest and Egg Losses

Data on the success of nests found at Eagle Creek are summarized in Table 1. Two years of high success (1960, 1961) were followed by three seasons in which only slightly more than half of the nests hatched. The main loss of eggs was through predation, largely by weasels (*Mustela erminea*).

I do not know why losses to predators increased so drastically after 1961. An increase in predator numbers is a possibility; in that connection, it should be mentioned that microtine rodent populations on the study area increased noticeably in 1962, and remained high in 1963 and 1964. Nest sites chosen by ptarmigan in 1962-64 did not appear more vulnerable to predation than sites selected previously. Predators may have learned to follow human trails to nests; opportunism of this sort is well recognized by waterfowl investigators. However, high nest losses in 1962 through 1964 occurred 8 miles east of Eagle Creek, on an area visited only after nests had hatched.

Ptarming nests with females incubating are much easier to find than nests that have been destroyed, especially when the predator removes the eggs. This fact leads to an overestimate of nesting success when all nests found are included in calculations. This showed clearly when the success of the first 50 percent of nests found in all years was compared to the success of the second 50 percent. Only 27 of 49 nests (55 percent) found early in the season subsequently hatched, whereas 40 of 50 nests (80 percent) found later were successful. The difference appeared only in years of high nest loss. Clearly, estimates based on these data are maximal.

Renesting

No direct evidence was obtained that renesting occurred in this population.

Double or multiple peaks in hatching curves have been interpreted to show the extent of renesting in some species of gallinaceous birds (see review by Westerskov, 1957). Studies at Eagle Creek showed that in 5 consecutive seasons, 90 percent of the hens laid eggs in a 7- to 10-day period each year, which showed as a single peak when plotted graphically. Late-hatching nests, which could have been second attempts, comprised 3 percent of the total number of records (228) obtained from nests and known-age broods. Renesting apparently is not important in determining the productivity of the breeding population at Eagle Creek.

Survival of Chicks

Estimates of chick survival to early August are based on counts of chicks in broods throughout the entire brood season. Losses of chicks at Eagle Creek are given in Table 1. Highest losses seem to have been sustained in 1960, but the small number of late-season counts prevents much confidence in that conclusion. Lowest losses occurred in 1961; intermediate losses of chicks characterized 1962 through 1964.

Causes of the disappearance of chicks were rarely discovered. Gryfalcons (*Falco rusticolis*) were observed to catch two chicks on the study area, and remains, including bands, of ptarmigan were found at a golden eagle (*Aguila chrysaets*) nest 5 miles from the study area. One nest was found in which the young ptarmigan had died 2 feet away just after hatching, perhaps due to rain. No factor could be singled out as being of greater importance than other causes of chick mortality.

TABLE 1. REPRODUCTION AMONG ROCK PTARMIGAN AT EAGLE CREEK, ALASKA, 1960–64

Year	Nests Found	Av. Clutch	Percentage of Nests Hatching	Chicks Per Brood, August (No. of Broods)	Percent Loss After Hatching	Summer Gain
1960	12	8.2	83	5.3 (10)	34	2.7–3.1
1961	20	7.4	85	6.1 (38)	10	3.1–3.3
1962	21	7.0	55	5.5 (50)	20	2.3–2.5
1963	32	6.5	56	4.8 (75)	17	2.0–2.3
1964	16	6.6	56	5.1 (35)	23	2.1–2.3

Summer Population Gains

The number of ptarmigan alive early in August in comparison with the number present in the breeding population (Table 1) was higher in 1960 and 1961 than in later years. This pattern is similar to that described for nest losses; nesting failure apparently was the most important factor determining relative summer population increases. Changes in clutch size may have been responsible for the slightly smaller gains in 1963 and 1964 than in 1962, as nest losses were the same each year.

POPULATION LOSSES, AUGUST TO MAY

Because of extensive fall movements by members of the summer population, particularly of females (Weeden, 1964), I could not watch individual birds from late August to May. The fate of Eagle Creek ptarmigan as individuals was known only from recaptures or reports of banded birds; their survival as a group could only be inferred from the number and age of birds present the following spring. Under such conditions, mortality from August to May can be estimated if emigration to new breeding areas is equalled by immigration of birds of the same sex and age to Eagle Creek. This assumption is tenable if, as breeding habitat, Eagle Creek is no more and no less attractive to ptarmigan than surrounding areas, and if population levels and fluctuations at Eagle Creek are similar to those in adjacent alpine areas. Mortality estimates that follow are based on the assumption that those conditions prevail.

Extent of Mortality

Estimates of juvenile and adult mortality between August and May (inclusive) are in Table 2.

TABLE 2. FALL-TO-SPRING LOSSES AMONG ROCK PTARMIGAN, EAGLE CREEK, ALASKA, 1960–64

Percent Mortality

Period	Old Birds		First-Year Birds	All Ages
	Males	Females		
1960–61	41	38	40–49	40–46
1961–62	54	68	60–63	60–63
1962–63	69	74	57–62	64–67
1963–64	50	29	80–84	53–57

Because of inherent biases in nesting studies, fewer chicks may have been present on the study area in 1962 and 1963 than listed in Table 2; mortality during the following winters, therefore, would be less than given in the Table. Further, inaccuracies of age determination of females in spring in 1961 and 1962 probably resulted in overestimates of the survival of adult hens. Despite these two sources of error, some conclusions may be safely drawn about the extent and pattern of winter losses of rock ptarmigan from the study area. Among adults, losses of both sexes increased from a low in 1960-61 to a high in 1962-63. In 1963-64 survival of adult hens improved more than survival of males. The sexes were present in nearly equal numbers (127 males, 117 females) in August 1963, which means that the differential mortality occurred between August and late May.

I conclude that mortality of juveniles was lowest in the winter of 1960-61, highest in 1963-64, and intermediate in 1961-62 and 1962-63. The sex ratios of chicks in August were not known, so that comparisons cannot be made between male and female death rates unless 1:1 summer sex ratios are assumed. Spring populations contained approximately the same number of yearling males and females each year until 1964, when yearling females were very scarce. Either more juvenile females than juvenile males died between August 1963 and May 1964, or there were many more male than female chicks in early August 1963.

Known Causes of Mortality, August to May

Hunting, predation by wild animals, and accidents have caused the death of rock ptarmigan on the study area during fall, winter, and early spring. Other mortality factors have not been detected. The relative importance of each of the three known causes of death and their individual or combined contribution to total mortality as estimated in the last section, are not known.

Sportsmen hunt for ptarmigan at Eagle Creek for 2 to 2½ months annually, beginning in mid-August. The alpine area occupied by rock ptarmigan becomes inaccessible due to snowdrifts on the Steese Highway from 2 to 6 weeks after the end of road maintenance early in October.

Of 1164 rock ptarmigan banded at Eagle Creek from 1960 through 1964, 93 (8 percent) were shot and reported by hunters. A higher proportion of adult cocks were shot (41 returns of 263 banded, or 16 percent) than adult females (16 of 341 banded, or 5 percent) or birds-of-the-year (36 of 560 banded, or 6 percent). This reflects the longer period during which males can be found at Eagle Creek in autumn, as well as a tendency for resident adult cocks to be shot disproportionately even when other sex and age groups are still living on the area. I cannot estimate the number of banded birds killed but not reported, or of crippled birds. If two banded birds were shot for every one reported (as shown for various waterfowl by

Geis and Atwood (1961), the harvest of adult male rock ptarmigan would constitute a major part of the total annual mortality of that population segment. The same would not be true for immatures or for adult hens.

The remains of rock ptarmigan killed in autumn, winter, and early spring were found annually during our summer studies at Eagle Creek: 12 in 1960, 65 in 1961, 27 in 1962, 88 in 1963, and 86 in 1964. Ten of these (4 percent) contained bands. Evidence at the remains suggested that gyrfalcons and foxes (*Vulpes fulva*) killed most of these birds, but some could have died of disease or accidents before being eaten. Eleven rock ptarmigan were found that were victims of accidents. Eight were buried by a small snow slide, one was killed when it flew into a wire, and two probably were trapped in snow roosts during storms.

DISCUSSION

From 1960 through 1964, reproduction resulted in a density of rock ptarmigan in August averaging about 2.5 times that of initial breeding densities at Eagle Creek. Breeding populations would be stable if such summer gains were followed by losses between August and the following May of 60 percent of birds alive at the start of the period.

Ptarmigan breeding densities were not the same from year to year, the differences occurring after varying amounts of reproduction and winter losses. The summer increase in 1960 was considerably greater than the 5-year average, and winter losses were low; breeding stock was more abundant the following spring. Production and survival of chicks to early August were even better in 1961 than in 1960, but winter losses increased by almost 20 percent. Although breeding pairs were more numerous in 1962 than in the two preceeding years, the rate of gain between 1961 and 1962 was half of that between 1960 and 1961. The scales tipped in 1962. Reproductive success declined, winter losses increased, and 1963 breeding populations dropped approximately to 1961 levels. Low summer gains and high winter losses were repeated in 1963 and 1964, resulting in breeding densities in 1964 only slightly higher than at the start of the study 5 years before. Below-average summer gains were recorded in 1964. Unless winter losses this season (1964-65) are less than about 55 per cent of August populations, even lower breeding-pair counts can be expected in 1965 than in 1964.

Rock ptarmigan numbers at Eagle Creek apparently fluctuated strongly from 1951 to 1959. Theses by DeLeonardis (1952) and Roberts (1963), and data in the files of the Alaska Cooperative Wildlife Research Unit and Alaska Department of Fish and Game suggest the following sequence of population changes:

1. Moderately low breeding densities in 1951, with high summer gain;
2. High breeding densities, high clutch size (8.0-9.0) in 1953, with moderately heavy loss of young; very high success among ptarmigan hunters, indicating an abundance of ptarmigan in autumn;
3. Continued excellent hunting in 1954, 1955;
4. Sharp decline in winter of 1955-56, followed by breeding densities of 2.0 pairs per square mile in 1956; low average clutch size (6.2), moderate nesting success, good chick survival in 1956;
5. Continued very low breeding densities in 1957, 1958.
6. Somewhat higher breeding densities in 1959, followed by excellent production of chicks and good survival of juveniles throughout the fall.

In summary, two population peaks seem to have occurred at Eagle Creek since 1951. One was in 1953 or 1954. The other, of lower amplitude, occurred in 1962. A precipitous decline occurred after the 1953-54 peak, and a slower decline has taken place after the 1962 peak.

From 1960 through 1964, predation on eggs was the important factor determining summer gains, augmented or partly counteracted by changes in clutch size and early survival of chicks. Summer gain and its components did not seem to be related directly to population density. Whether any or all of those factors are related in the manner of delayed density dependent phenomena (see Lack, 1954:118) remains to be seen.

Winter losses loom as the biggest single set of unknowns in this study. Hunting did not seem a major component of August-to-May losses, although, in the case of adult males, this factor could be important. Predation may be very important, but direct evidence is scarce. After the two winters of lowest losses (1960-61, 1961-62) 92 carcasses of rock ptarmigan were found on the study area; in contrast, 174 carcasses were found after the winters of 1962-63 and 1963-64, when the percentage of August birds lost in winter was high.

Jenkins (1961) and Jenkins, Watson, and Miller (1963) have found that the spring population levels of partridge (*Perdix perdix*) and red grouse (*L. lagopus scoticus*) are always as high as the habitat can support, and sometimes higher. They interpret changes in breeding densities as changes in carrying capacity of the habitat. On the other hand, Blank and Ash (1962) studying partridge on an unmanaged area in England, found that a variety of factors, including hunting, disease, weather, and reproductive success, might decrease partridge numbers below the carrying capacity of the habitat in spring. Thus the stock of birds surviving the winter might occasionally be, but usually was not, enough to fill all potential places in which the birds could live.

Future work at Eagle Creek will include attempts to discover whether the rapid changes in breeding stocks observed are related to rapid changes in the number of suitable breeding places for ptarmigan, or whether factors affecting reproduction and survival throughout the year determine the number of birds available to stock the tundra in spring.

SUMMARY

Initial breeding stocks of rock ptarmigan (*Lagopus mutus*) on a 15-square-mile area in east-central Alaska rose from 88 cocks in 1960 to a peak of 170 in 1962, then declined to 109 in 1964. Two years of good chick production were followed by three years of lower production. Clutch size decreased significantly from 1960 (av. clutch 8.2) to 1963 and 1964 (av. clutch 6.5, 6.6), but predation on nests by weasels (*Mustela erminea*) accounted for most of the deceased production in 1962-1964. Early survival of chicks did not vary greatly. Mortality from late summer to spring was only 40 to 46 percent for all ages in 1960-61, but death rates rose in 1961-62 and 1962-63 to 64 to 67 percent. Overall mortality was 53 to 57 percent in the winter of 1963-64, with a very high loss of young birds balanced by excellent survival of adults, especially hens.

ACKNOWLEDGMENTS

Alaska Department of Fish and Game Biologists Alan Courtright, Laurence Ellison, and Robert A. Rausch improved the original manuscript of this paper. Thomas Dean, James Erickson, David Hatler, and Rodney Herrick assisted in the field work. My sincere thanks are extended to all of those people for their contributions to this study.

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DISCUSSION

DISCUSSION LEADER MOSBY: Are there any questions?

MR. LUNDSTROM (Massachusetts): I was wondering about the increased predation by the weasel on nesting birds. Do you have any explanation of this as to the drop of other species or increase in other species?

DR. WEEDEN: I have lots of guesses. When you come right down to it, I wish I had been counting mice all of this time because it looks as though mouse populations were low in 1960 and 1961. They were relatively high in 1962, 1963 and 1964. It is possible that weasel populations likewise respond to this and increase in numbers. Therefore if ptarmigan nests are found by weasels largely by chance, then the chance of a single ptarmigan nest being located by a weasel was much greater in the years of high predation than in the years of observed low predation.

There is also the possibility that weasels are becoming smart and are following me to the nests. This is very disturbing to a lot of waterfowl biologists, I know.

My studies have included a check of populations on an area eight miles to the east of Eagle Creek. I visit the area only once and make a count of broods and other birds I see. On this area, too, in 1960 and 1961 almost all of the hens had broods. In 1962, 1963 and 1964 about the same number of hens had broods as were observed on the Eagle Creek area. So it looks as though weasels or something increased the predation on the nests in that area, which I did not visit as I did the nests on the main study area.

MR. LUNDSTROM: One other question, on the difference of the plumage of the male, did you notice any difference in the sex ratio? Is there any differential relations? What are the sex ratios?

DR. WEEDEN: The sex ratios in spring are approximately equal. Most years my estimates have shown there were slightly fewer females, perhaps 5 to 10 per cent fewer than males in the breeding population. However, my estimates of the male population I believe are much more accurate than those for the female. Therefore it could be that the sex ratio as actually very close to equal every year.

MR. SCHEMNITZ (University of Maine): At the beginning of your paper, you described the unique habit of ptarmigan segregating in the winter into flocks of males and females. Do you have any information on survival differences that are caused by this behavior?

DR. WEEDEN: I am sorry, as yet I don't have anything more than guesses and I would enjoy talking with you about this personally. But I am not so sure I am ready to stick my neck out before a number of people.

However, just as a comment, this is not particularly unique among gallinaceous birds. Black grouse, for example, do the same thing. So do capercaillies. There have been some observations to show that sharptails do sometimes, so it is not unique. It probably is of some survival benefit to the species in the long run. I can't say what that is now.

DR. ERICKSON (Wisconsin): Along the same line, in regard to the segregation of the sexes and the very high survival of adult females, do you suppose there is a possibility or do you have evidence that there is segregation of the age groups? That is, young to adult?

DR. WEEDEN: None of the information I have from winter collection shows this to be the case. If you shoot into a flock and find that you have shot all females you are very likely to get a mixture of age groups. It seems most peculiar if young females and old females are doing the same thing and living in the same places in the winter, that the mortality rate should be so different as was observed in 1963 and 1964. I can't explain this right now. Of course, some of the very recent work in upland game bird biology, especially that of Dr. Bendell in British Columbia on blue grouse and of Drs. Jenkins and Watson over in Scotland on red grouse have shown that the ability of chicks to survive differs between years. It could be, therefore, that something, with a capital "S" has determined that chicks produced in 1964 simply were not going to have a good survival rate during the winter but that the adults living right alongside of them were for some reason much more likely to survive.

That is one of the great fields I think for continuing research in upland game bird work.

DISCUSSION LEADER MOSBY: Are you obtaining enough returns from banded birds within the 10-year period to give you life table data?

DR. WEEDEN: Although the Eagle Creek area is transected by a highway and although hunters do hunt in the area, the total take of resident ptarmigan is very small. I have banded about 1200 ptarmigan in the five years of the study and have returns enough to show that about 15 percent of the adult males that I banded in the area are taken by hunters. About 5 percent of the adult females are taken by hunters and about 6 to 8 percent of the juveniles of both sexes are taken by hunters.

The season is short, although actually the legal season extends from mid-August until mid-April. But hunters cannot get to the area except for about two months of the year. Secondly the resident birds begin to move very rapidly during September so that many of the birds shot by the hunters are birds from other breeding grounds.

In direct answer to your question, then, Dr. Mosby, I think I will have the information that is suggested of life table data, but I do not think I will be able to construct a really final one because the total number of returns I will be working with for any sex or age group will be very small.

DISCUSSION LEADER MOSBY: If there are no other comments, I should like to commend the group for their participation in the discussion. I think we all agree these discussions are oftentimes some of the most illuminating parts of these papers because we ask questions that specifically concern us. I would like to thank you for your participation and turn it back to the chairman.

CHAIRMAN MCKEAN: I personally would like to thank the seven speakers who so ably presented their subjects today. I think they were all outstanding and they all kept to the time limit we provided. We are precisely on time. I want to thank Dr. Mosby for his very excellent leading of discussions, and Jack Forbes down here, our fully licensed projectionist.

We are grateful for the interest that you people have shown and hope that you got as much out of it as we did. Thank you.

TECHNICAL SESSION

Wednesday Morning—March 10

Chairman: TONY J. PETERLE
Professor, Department of Zoology and Entomology, Ohio State University, Columbus

Discussion Leader: KENNETH C. SADLER
Biologist, Missouri Conservation Commission, Jefferson City

FIELD AND FARM RESOURCES

AN ANALYSIS OF THE EFFECT OF ARTIFICIAL NEST BOXES ON A GRAY SQUIRREL POPULATION[1]

F. S. BARKALOW, JR. AND R. F. SOOTS, JR.
North Carolina State University at Raleigh

The possibility that artificial nest boxes would raise the carrying capacity of an area for squirrels has been the subject of considerable interest and speculation in wildlife circles (Allen, 1943; Allison, 1953; Brown and Yeager, 1945; Hesselschwerdt, 1942). In an attempt to answer this question, a study was begun in March 1956 in the William B. Umstead and Reedy Creek State Parks near Raleigh, N.C., to test the effect of nest boxes on an unexploited population of gray squirrels.

The two contiguous parks containing 5080 acres of almost unbroken Eastern Piedmont, subclimax and climax, woodland have been closed to hunting and logging for nearly 30 years. A continuous 2500-acre tract along the southern half of the two parks has been reserved as a Natural Area. Two replicated experimental tracts, each approximately 200 acres in extent and ¼ mile apart, were located within the Natural Area near the park boundary. The tract in Reedy Creek park was designated as Area I, and the 200-acre tract in Umstead was designated as Area II. Each area was divided into

[1]Financed by the N. C. Wildl. Resources Comm. (PR project W-44-R) and the Natl. Sci. Foundation (Grant G-20739). The research areas were provided by the N. C. Dept. Conserv. and Development, Div. of State Parks.

two 100-acre plots which were further subdivided into one-acre units. The acre units were given letter designations from B through U along the east-west axis of each area and the north-south axis was numbered from 0 to 10 (Fig. 1). Lines B-K on each area always received the same treatment; lines L-U were paired in a similar manner.

Of the 949 natural cavities located on the two areas, 568 were classified as good litter dens, 94 were considered poor, and 287 were of escape value only. Of the good dens on both areas, lines B-K contained 258 and lines L-U had 310. Of the combined good and poor cavities, 281 were on lines B-K and 381 occurred on lines L-U.

The investigation was conducted in three steps. In Phase I, July 1956—April 1960, two boxes per acre were erected on one-half of each of the 200-acre tracts (lines L-U) with the two remaining plots (lines B-K) serving as controls. At the beginning of Phase II, May 1960—May 1962, all boxes were removed from both areas, and in Phase III, June 1962—December 1964, the boxes were placed two per acre on the two previously unboxed plots (lines B-K) with the original boxed plots (lines L-U) serving as controls. Approximately 400 boxes were kept in continuous operation throughout Phase I, and 389 were maintained in Phase III. Both fall and spring live trap censuses were conducted on each pair of replicated plots from November 1958 through December 1964. See Soots (1965) for the plans and description of the light weight trap designed for use on the project. Nest box checks were conducted approximately each quarter. During Phase I only day box checks were made, with the exception of one exploratory night examination in July 1958. In the latter half of Phase III both day and night checks were made for the purpose of quantifying our subjective evaluations of box use and of securing data which might enable the testing of the Schnabel index values obtained during the live trapping period immediately preceding or following the box examination. Approximately 11,000 individual box examinations were made during the study.

The artificial dens provided for these investigations were spaced 35 yards apart between 10′ and 25′ from the ground along the north-south (numbered) axis and 70 yards apart on the east-west (lettered) axis. A rough sawed, untreated pine box (10″×10″×20″) permanently attached to the tree was employed in Phase I; while an improved and slightly smaller rough cypress box which could be detached from the tree (Fig. 2) and brought to the ground for examination, was used throughout Phase III (Barkalow and Soots, in press).

The 100 trap locations on each of the four one-hundred acre units were determined by a table of random numbers. During the fall

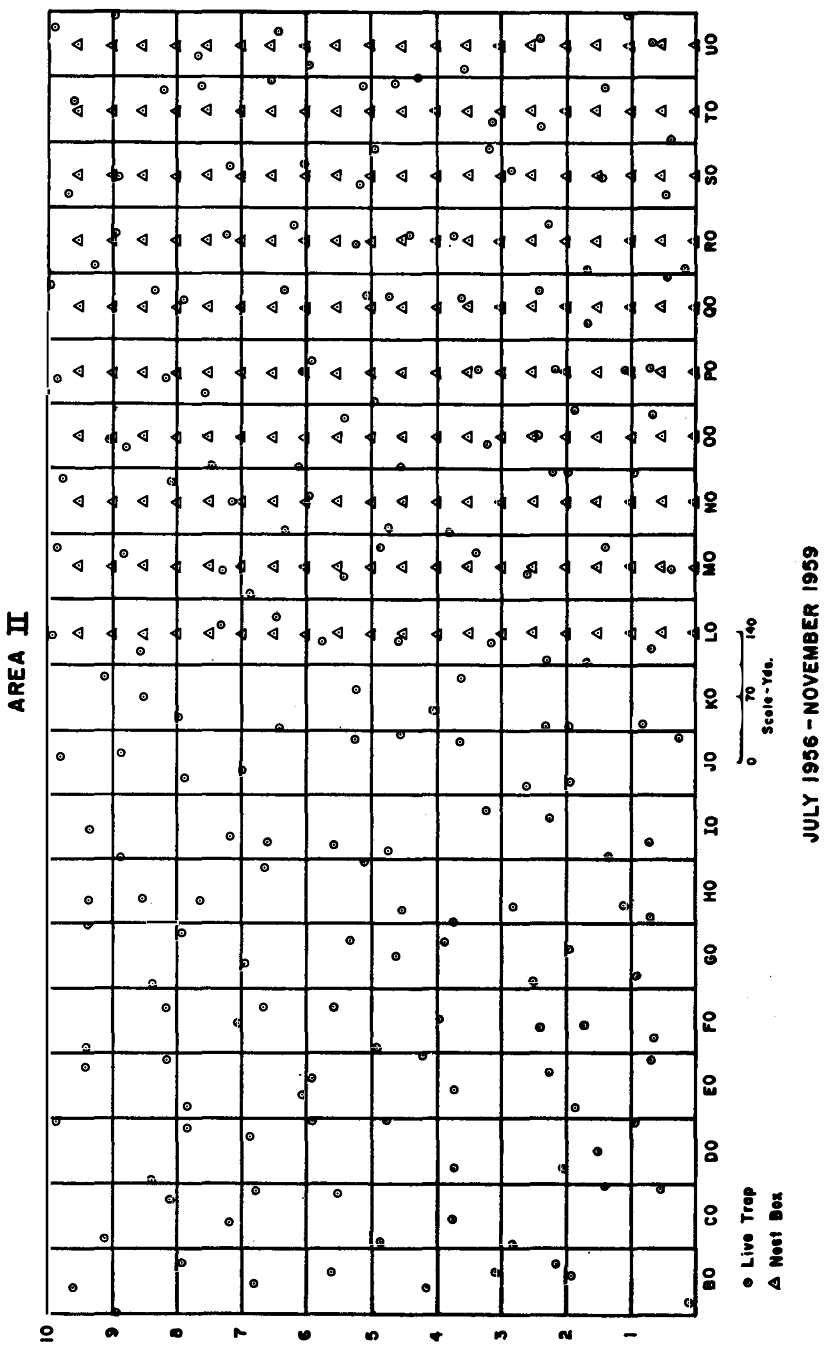

Figure 1. Grid map showing the randomized live trap positions and systematic nest box locations in Phase I.

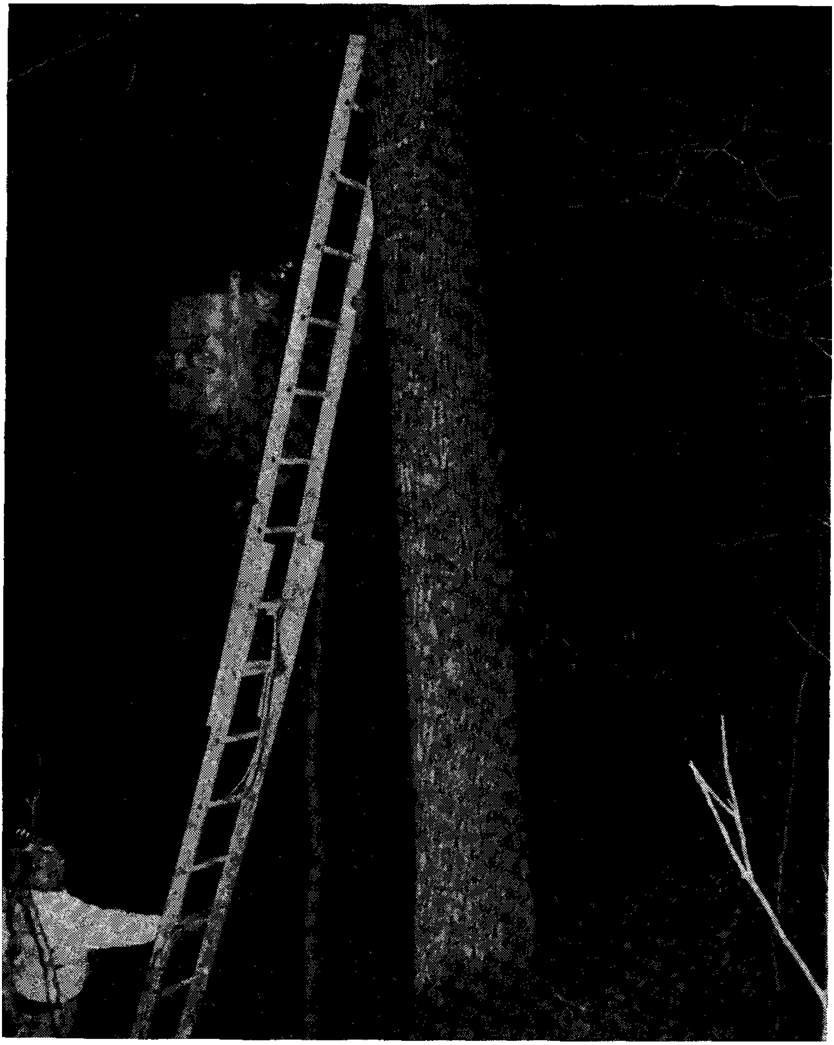

Figure 2. An artificial den which can be detached from the tree and brought to the ground for examination considerably reduces the time required for a night box check. Night examinations provide an accurate measure of actual box occupancy by gray squirrels.

1958 and spring 1959 censuses, 200 traps were set on the randomized sites within each acre on both the boxed and unboxed portions (Fig. 1). But beginning with the 1959 fall census, in order to reduce labor costs, traps set on the unboxed plots were placed on a grid pattern, one per acre, although the randomized locations on the boxed half of the area were maintained. Randomization was employed to avoid the introduction of capture biases resulting from the erection of the boxes on a systematic grid pattern. The trap line was approximately 12¾ miles long with the trap locations randomized on both plots. (Phase I, fall 1958—spring 1959), and 10¾ miles in length with one plot randomized and the other gridded (Phase I fall 1959—spring 1960 and Phase III). During the unboxed Phase II, the traps were systematically set on both plots, shortening the trap line to 8¾ miles. Two to four assistants were used each afternoon to check the traps. Traps were run as late as possible each afternoon to avoid confining animals overnight.

All animals captured in leaf nests, nest boxes or live traps were marked either by toe clipping, if they were unweaned young, or by placing serially numbered metal fingerling tags in both ears of the larger animals. Toe clipped animals were also ear tagged when recaptured later as yearlings or adults.

One area was trapped until a stabilized Schnabel index was obtained for each plot (lines B-K and L-U); following which, the 200 traps were transferred to the second area and the process repeated. Beginning in the fall of 1958 an attempt was made to census both areas each fall and spring. An estimate on Area II was not obtained during the fall 1958 census due to a period of usually bad weather. During the fall of 1959 a bumper crop of hickory nuts and red and white oak acorns blanketed both areas, making it impossible to attract enough squirrels into our traps to obtain an estimate. With the exception of the fall of 1958 trapping period on Area II and the 1959 fall census on both Areas I and II, the live trapping program was conducted without difficulty.

The Schnabel formula (Schnabel, 1938) as modified by D. G. Chapman (1952) was used in calculating the indices in the first two columns of Tables 1 and 2. A discussion of the application of the modified Schnabel formula to our data will be presented in a later paper.

The boxes were erected on lines L-U during July of 1956, and the first live-trap census was made during the fall of 1958. All boxes were removed from lines L-U following the production of the 1960 summer litters. The fall 1960 indices were considered a part of the Phase I rather than Phase II estimates due to the residual effect of the boxes. A seven census average during the fall 1958—fall 1960 interval gave average Schnabel indices of 99.8 for the two boxed plots and 60.5 for the unboxed plots (Table 2). Six censuses were conducted during the spring 1961—spring 1962 period of Phase II

TABLE 1. SCHNABEL AND SQUIRRELS/2000 TRAP DAYS INDICES*

	CENSUS PERIOD	SCHNABEL INDICES LINES B-K	SCHNABEL INDICES LINES L-U	SQUIRRELS/2000 TRAP DAYS LINES B-K	SQUIRRELS/2000 TRAP DAYS LINES L-U
	Boxes Erected on Lines L-U, June-July 1956				
PHASE I		Unboxed	Boxed	Unboxed	Boxed
	Fall 1958*	19	29	10	19
	Spring 1959	33	103	25	40
	Spring 1960	113	288	25	32
	Boxes Removed from Lines L-U, May-August 1960				
PHASE II		Unboxed	Unboxed	Unboxed	Unboxed
	Fall 1960	259	279	34	42
	Phase I—Phase II Adjustment Period Ends				
	Spring 1961	84	58	28	28
	Fall 1961	71	62	46	35
	Spring 1962	81	81	50	58
	Boxes Erected on Lines B-K, June 1962				
PHASE III		Boxed	Unboxed	Boxed	Unboxed
	Fall 1962	77	85	19	30
	Spring 1963	32	71	18	41
	Phase II—Phase III Adjustment Period Ends				
	Fall 1963	115	83	55	37
	Spring 1964	132	106	86	64
	Fall 1964	78	65	62	46

* Estimate obtained only on Area I in Fall 1958. All others represent the combined values obtained from both Area I and Area II.

TABLE 2. COMPARISON OF INDICES BY PHASES

	SCHNABEL INDEX/100 ACRES		SQUIRRELS/2000 TRAP DAYS	
Phase I	Boxed (L-U) 99.8	Unboxed (B-K) 60.5	Boxed (L-U) 36.8	Unboxed (B-K) 25.1
Phase II	Unboxed (L-U) 33.5	Unboxed (B-K) 39.3	Unboxed (L-U) 39.8	Unboxed (B-K) 37.8
Phase *III	Unboxed (L-U) 42.3	Boxed (B-K) 54.2	Unboxed (L-U) 52.5	Boxed (B-K) 74.2

* Exclusive of Adjustment Period F62-S63.

when all boxes were removed. Schnabel indices averaged 33.5 for the former boxed plots (lines L-U) and 39.3 for the unboxed plots (lines B-K). During June 1962, two boxes per acre were put up on the two plots (lines B-K) which had formerly served as controls. Lines L-U on both areas were left unboxed. The interval between the summer of 1962, when the boxes were erected, and the spring of 1963 represents a period of adjustment within the squirrel population to the increased number of nesting and escape dens on the boxed plots. Any significant benefits to the population from the boxes would not likely be reflected before the fall 1963 census since the boxes were not erected in time to insure maximum use by females producing 1962 summer litters and any differential survival of spring young born in nest boxes would not show up in our live trapping results until the fall of 1963 since these young were still unweaned at the time of the spring 1963 census. The indices obtained during the adjustment period of Phase III were excluded from the stabilized (fall 1963—fall 1964) portion of the Phase III estimates below. Six censuses following the adjustment period gave average Schnabel indices of 42.3 for the unboxed (lines L-U) and 54.2 for the boxed plots (lines B-K).

The combined Schnabel values obtained from Areas I and II, with the exception of the fall of 1958 which was based upon Area I only, are represented by Table 1 under the heading Schnabel Indices. An index using the number of Squirrels/2000 Trap Days was also calculated for each plot during the fall 1958—fall 1964 trapping interval (Table 1). Calculation of the trap day index values was made on the basis of the number of different squirrels captured per 2000 trap days within each census period and within each phase. The indices obtained from Table 1 are plotted in Fig. 4. It can be

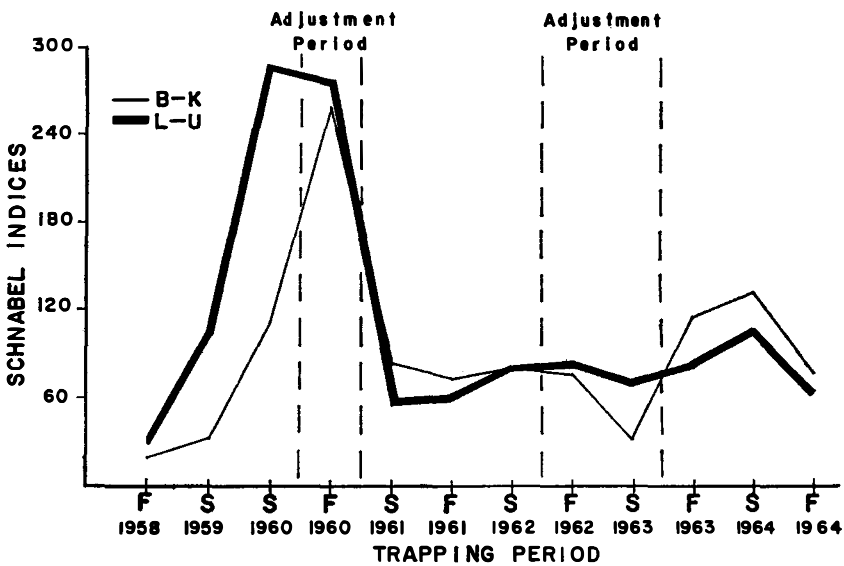

Figure 3. Combined Area I and Area II Schnabel Indices. Nest boxes placed on lines L-U during summer 1956 and removed during summer 1960. No boxes present during Sept. 1960—June 1962 interval. Boxes erected on lines B-K in July 1962 and present through Dec. 1964.

seen that the within census indices on the boxed plot during the fall 1958—fall 1960 were higher than those on the unboxed plot during the same interval. It is also shown that following the adjustment period in Phase III the boxed plots have higher indices than the now unboxed plots.

The Schnabel indices from Table 1, plotted in Fig. 3, generally reflect the overall changes in the population during the six year trapping period; however, the presence of a large number of "trap-happy" yearling squirrels on the boxed plots during Phases I and III (206 boxed versus 124 on the unboxed) resulted in a differential lowering of the Schnabel indices on the boxed plots.

Within the census period, recapture rate based on 599 adults was 29.4%; whereas, 45.9% of 344 yearlings were recaptured during the same period. The difference in the recapture rate between the two age groups was found to highly significant ($\chi^2 = 12.40^{**}$). Were it not for the greater actual number of yearling squirrels on the boxed plots the differences between the Schnabel indices in both Phases I and III would have been even greater. In Fig. 3 the boxed plot indices are represented by L-U during the fall 1958—fall 1960 period and by lines B-K during the fall 1963—fall 1964 interval. It is suggested that the reason for the larger number of yearlings on the boxed plots is due primarily to the greater survival of litters born in the nest boxes and to the additional protection provided by the proximity of the systematically located escape dens that were added to the natural cavities already present. The evidence in support of the above hypothesis is discussed in more detail below. The possibility that the artificial nest boxes may curb dispersal of young born on the treated area and tend to hold those individuals dispersing into the area is being investigated.

The index pattern during the three phases of study (Tables 1 and 2 and Figs. 3 and 4) was the same for both the Schnabel and the Squirrels/2000 Trap Days techniques: namely, higher on the boxed plots (lines L-U) during Phase I; no essential difference between the plot indices in Phase II, when boxes were not present and again higher on the boxed plots (lines B-K) in Phase III.

It was assumed that the reversal of the treatment would overcome or reduce the effect of any between-plot differences on the two areas. There also appeared to be no significant difference in the overall average trapping success when the index of Squirrels/2000 Trap Days obtained for lines B-K (35.3) is compared with the index for lines L-U (38.8). The amount of trapping effort was essentially equal with 41,221 trap days recorded on lines B-K and 41,339 on lines L-U.

Since the higher population indices on the boxed plots could be

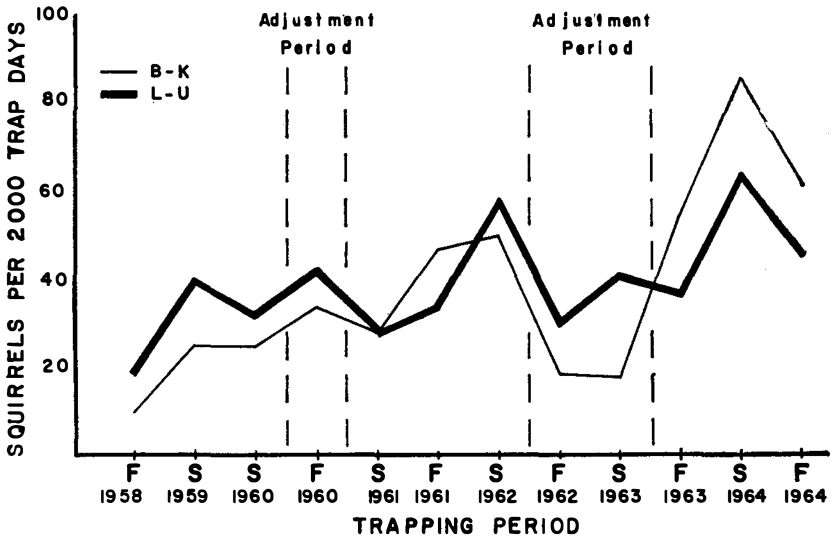

Figure 4. Combined Area I and Area II indices of Squirrels/2000 Trap Days. For description of treatment see Fig. 3 above.

due to the individuals on the boxed areas being easier to trap, an attempt was made to determine whether there was a difference in trap response between the squirrels on the boxed and those on the unboxed plots. If the frequency of first recapture can be used as an index, our data indicates that there was no difference between the trap response of squirrels on the boxed and unboxed plots (Table 3).

The index differences between the boxed plots and the unboxed plots might also be due to a more favorable survival rate of both young and adult squirrels on the boxed plots. Evidence in support of the higher survival hypothesis of nest-box young was obtained from an analysis of the live trap recapture data on animals that were marked in litters captured during the summer leaf nest and

TABLE 3. WITHIN PERIODS RECAPTURE RATES BETWEEN THE BOXED AND UNBOXED PLOTS.

	BOXED		UNBOXED		
	Captured	Recaptured	Captured	Recaptured	χ^2
Adult ♂♂	144	37	121	37	.465
Adult ♀♀	162	47	172	55	.205
Yearlings	194	90	150	68	.068

nest box checks of Phases I and III. Using only those young from litters found in leaf nests on the boxed plots and those young found in the nest boxes on lines L-U in Phase I and lines B-K in Phase III, it was found that 17.5% of the 286 young from nest-box litters were subsequently retrapped; whereas, only 7.7% of 117 young from leaf nests litters on the same plots were retaken. The difference between the recapture rate of the groups was found to be significant (χ^2=4.81*).

The possibility of a higher survival rate of adults on the boxed plots is suggested by the live trap recovery records obtained four or more months after the animals' first capture in a trap. Of 305 squirrels captured on the boxed plots during Phases I and III, 43.9% were retrapped after a minimum interval of four months; while only 29.0% of 279 live trapped squirrels from the unboxed plots have been recaptured after a minimum four months' delay. In contrast to the differential rates above, the within census period recapture rates of squirrels of comparable ages was almost identical on the boxed and unboxed plots.

Since a differential movement by the leaf nest young and unboxed plot adults could also be responsible for the lower recapture rates obtained for these two categories, a study of movements and home ranges was undertaken. This study is not complete, but if a differential movement pattern exists it is not apparent at this time. During Phases I and III only 9 squirrels crossed from the unboxed to boxed plots and 11 moved from the boxed to the unboxed plots. Thirteen adults captured only on the boxed plots in Phase I were subsequently recaptured on the boxed plots during Phase III. Of those squirrels captured on the unboxed plots in Phase I, none were taken on the unboxed plots during Phase III. Squirrels moving only between the adjacent plot lines K and L were not included in the tabulation above. In view of the lack of evidence of a differential movement pattern, it is hypothesized that the higher percentage of live trap recaptures of the nest box young and the adults on the boxed plots is a reflection of lower mortalities in these two categories due either wholly or in part to the greater protection provided by the artificial nest boxes.

SUMMARY

During the eight and one-half year study, 2242 individual gray squirrels captured in live traps, nest boxes, and leaf nests were handled from one to 30 times each, and of these, 1190 were of known age ($\pm$1 week).

The combined Area I and Area II index values (Table 1) clearly indicate a higher population of squirrels on the boxed plots (lines

L-U) during the fall 1958—fall 1960 period and also on lines B-K during the post adjustment period of Phase III (fall 1963—fall 1964) when the boxed areas were reversed. It is suggested that the higher populations on the boxed areas may be explained by the increased survival of the nest box young and adults on the boxed areas. Our observations indicate that the increased survival of both the young and adults is probably due to the greater protection from natural enemies, accidents, and weather furnished by the boxes.

The boxes may also reduce the dispersal rate of animals from the treated areas as well as holding dispersing individuals which come from outside the area.

It is our belief that under the conditions of the experiment, the index values reflect population differences in each census period. It is our further belief that the population differences between the boxed and unboxed plots during Phase I and the post adjustment period of Phase III may be attributed to the influence of the artificial nest boxes. It is concluded, therefore, that the nest boxes did increase the carrying capacity of each of the treated plots.

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DISCUSSION

VICE CHAIRMAN SADLER: Thank you very much, Dr. Barkalow.

I am sure that those of you who live in the eastern half of the United States appreciate the significance that squirrels play in the harvest potential. This is an eight-year study involving one of the most important species that we have. Dr. Barkalow has said, in addition to any questions you might have on the study which he has given, there will be an additional opportunity for us to discuss the multiple biology problems he encountered and which will provide us with some excellent data.

Are there any questions?

MR. VERNE E. DAVISON (Soil Conservation Service): Could you estimate whether or not the two boxes per acre helped you get the desirable level or would less than that number have done it?

DR. BARKALOW: I suspect that half that number would have done the trick, but we wanted to saturate the area with dens in order to achieve the maximum results.

VICE CHAIRMAN SADLER: Could you tell us the role that mast played in this setting?

DR. BARKALOW: We had a very clear indication of the effect of mast on the squirrels. During the first period of our study we had some fantastic mast crops, including the one in the fall of 1959, in which we just couldn't attract any squirrels to our traps. Following the fall 1959 bumper mast crop, we had a real bulge in the squirrel population. At the time of our spring 1960 census we found 37.5% of the adult female lactating. Two years later, in the fall of 1961, the mast crop was almost a complete failure and the squirrels were in an extremely poor condition throughout the winter. At the time of the spring 1962 census only 1.4% of the adult females were found to be lactating.

VICE CHAIRMAN SADLER: One further point of clarification. Did you have any indication of whether the mortality in the population was occurring with reference to the females lactating or not lactating? Was this a failure due to ovulation?

DR. BARKALOW: Of course, we do not know for sure since we did not sacrifice any squirrels, although we lost a few occasionally in traps. We found practically no evidence of breeding since the females apparently had not come into heat. If they did breed most of them did not conceive.

PROBLEMS OF MULTIFLORA ROSE SPREAD AND CONTROL

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This paper has two main objectives. The first is to provide information about the spread and control of multiflora rose (*Rosa multiflora* Thunb.). The second, and perhaps more important, is to examine some of the issues raised by the multiflora controversy; and to suggest perspectives for resolving them. The central thesis of the report will be that multiflora has developed into an appreciable nuisance over much of its introduced range; and that conservation agencies have been reluctant to recognize or admit this, and embarrassingly slow to agree on how to cope with this development. It is not suggested that every planting has become a nuisance to every landowner, but that this is an increasingly common experience generally throughout the areas in which it has been planted in quantity and grown successfully.

The statements above may still sound like heresy to some. To others, this whole discussion may seem like beating a dead horse, but I have found that agreement is not as general as it might seem. I remember Huskins' three stages of idea acceptance that Allen (1954) chose to quote: first, we do not believe it; second, it is of no importance anyway; and third, we knew it all the time. I have encountered all three stages. The selective myopia referred to by both Yambert and Calkins in last year's Conference is characteristic of this situation, and disagreement continues to surround the question. It involves not only what we used to think and say about it, but how we presently interpret the facts after 15 to 20 or more years of experience, and how we interpret our conclusions to the public, now and in the future.

In a recent "Message for Biologists," Secretary of the Interior Stewart L. Udall (1964) had this to say:

> Perhaps the most important message I can leave with you . . . is that you should speak out directly and frankly on what you know about evolving controversies that concern our environmental problems. . . . Don't wait to be asked. Offer your information as soon as it is available. Interpret what you know so that your information is understandable and logical to people with practical minds. . . . Your interpretations, controversial as they may be, are far superior to unfounded rumor and misconceptions.

Mr. Udall also suggested that our time will be known as "the age in which man began to assess the negative as well as the positive sides of his actions. . . ." I suggest that the positive side of multiflora has been amply championed in the past, and that a useful purpose will be served here by examining the negative side. This has been a major episode in the history of scientific wildlife management and we had best learn from it what we can in this period of increasing and conflicting demands upon resources and techniques.

I first encountered the question in 1961 as a newcomer to the Patuxent Wildlife Research Center in Maryland. One of the major early functions of this 2700-acre research area had been the testing and demonstrating of proposed conservation measures in their relation to both wildlife and agriculture. The Center includes three farm sites containing over 400 acres of open land, and almost 3 lineal miles of multiflora hedges had been planted here between 1947 and 1956. Asked to evaluate these plantings, I was surprised to find among some of the staff an unsympathetic reaction to the nuisance problems that had developed. Some favored complete eradication of the plant if possible. In the literature, I found that Durward Allen (1949) had written: "Charles A. Dambach . . . suggests that perhaps we are going forward too rapidly with this plant . . . he cautions that somewhat similar bubbles have burst in the past. While it appears certain that this rose will be useful on many farms, to employ it promiscuously may be a dangerous thing. If it becomes a nuisance, it will be difficult to sell farmers on other new ideas." In 1950, Rosene followed with: "Control will be necessary if multiflora rose is to be kept from spreading in idle land and unimproved pastures . . . farmers have had one unfortunate experience with a rose introduced from China. 'Cherokee' rose (*R. laevigata*), has become a pest locally in pastures, woodlands, and idle areas." Klimstra (1956) later stated "In the regions where agriculture is less intense and natural succession of woody vegetation and idle land relatively common, planting of multiflora rose is believed not only unwise but in general unnecessary, for natural conditions probably offer much more for wildlife. The emphasis now being placed on multiflora . . . might well result in the establishment of another nuisance plant. . . ." In the same year, Dale (1956) did not report a serious nuisance problem, but cautioned that even after a rose fence is grown, several more years would be required "to find out . . . whether it will spread as a weed."

These were not agronomists concerned with economic efficiency on the farm; these were wildlife people, dedicated to getting food and cover on the land, but retaining an ecological outlook sensitive to *all* interactions in the environment. The negative possibilities were being seriously considered from the beginning.

Agricultural interests also saw a negative side. Dickey (1952), an agronomist, put forth the most pointed warning, reminding us of the dangers and responsibilities involved in making inadequately tested introductions on a large scale. He concluded that "The Multiflora rose . . . *has* become a serious pest to farmers in at least two sections of the Northeast; the only places we know of where it has had the time and opportunity. The sad part of this whole proposition is that by the time this rose demonstrates its weedy propensities it will be too late to do anything practical to control it or stop its spread by birds over unlimited areas." Lloyd and Eley (1955) in an abridged version of an earlier administrative report described their findings that "Spreading was observed to idle and unmanaged areas, some unmowable pastures, and fencerows near seed-producing plants." They suggested that "more specific information be obtained on the use of chemicals in managing multiflora rose." Fletchall (1957) commented that "Multiflora rose is an increasing weed problem in Missouri," and more recently reinforced this opinion in correspondence. Other warnings and complaints have appeared from time to time in the popular press.

Looking further into the weedy proclivities of the Rosaceae, I found that a number of severe nuisance problems were to be found in this country and elsewhere. In every case it was those species that had been naturalized in new environments that were doing the significant damage. An Asiatic import, the Macartney rose (*R. bracteata* Wendl.) introduced long ago and earlier used for the same purposes as multiflora, is reported by Hoffman and Haas (1963) to have become a pest on about 500,000 acres of highly productive grasslands in some 40 southeastern Texas counties, where "the disadvantages outweigh any possible advantages." Searcy (1945) reports it widespread in the Black Belt of Alabama where enough land is covered in 9 counties to produce 1.5 million pounds of beef annually if it were in productive pasture. Rosene, quoted earlier, and Brown (1945) report the Cherokee rose also a pest in parts of the South—a bad one in parts of Mississippi, according to Dayton Klingman of the Agricultural Research Service, U.S. Department of Agriculture. The sweet brier, *Rosa Eglanteria* L., naturalized in New Zealand from England is reported by Little (1959) as a most serious weed of pastures where it is spread by birds. Tillyard (1930) mentions the introduced blackberry, *Rubus fruticosus*, as the worst weed in New Zealand, remarking that on the west coast of the South Island there is only one bush, but that bush is 200 miles long. Another *Rubus*, the "American bramble," is acting similarly in South Africa. And so it goes with certain other introduced shrubs, such as gorse, Scotch broom, and so on—all good ideas to start with.

At Patuxent we decided to learn what we could about this problem from experience on the land in the 15 years since the first rose plantings. This could not be a controlled experiment to test a hypothesis. We wished to ask new and different ecological questions, but any experiments to be done had already taken place as nature saw fit. We had available only the results of a natural "experiment of opportunity," and the retrospective method of epidemiology (White and Bailar III, 1956; Morris, 1957) was chosen as especially appropriate to the situation. In applying this technique, we examined as many instances of volunteer multiflora occurrence as possible, and then asked what it was that instances of spread had in common, and what ecological factors distinguished departures from this pattern. The epidemiologist works with such patterns of suggestive association, and seeks "to carry research to the point where the weight of evidence, considered in its entirety, justifies the immediate adoption of community programs for prevention and control." (Schweitzer, 1963).

The Patuxent study involved almost 36 miles of selected transects through high risk areas, several more miles in examination of farm fields and other areas, and the recording of occurrences discovered by the staff during other field work.[1] Additional evidence was concurrently sought in experience with multiflora in other Maryland habitats and elsewhere in areas of large-scale introductions.

[1]I wish to acknowledge the invaluable assistance of Carl Buchholtz in field work on these and other thorny problems in the study.

Analysis of the specific dynamics of this spread process as we have interpreted it must be the subject of another report, but we can summarize the significant features here. First, it should be remembered that spreading of a plant species is a process and not an event. At any moment in time, one is not able to view the finite end results—only suggestive clues as to the rate, direction, and potential final development of the process.

We found the amount and distribution of spread to be basically an inverse logarithmic function of distance from major seed source. The distance involved was sufficient to include all neighboring lands, but was usually measurable in yards even though single volunteer stands were found at distances of up to 1¼ miles from a source. The pattern of local incidence also reflected the interaction of a number of specific site factors which might either nullify one another or act together to increase the likelihood of invasion. We found that hedge plantings constituted a unique attraction as late winter food for seasonally-flocking, fruit-eating birds—either wintering or in spring migration. Although some less abundant or territorial fruit-eating resident species such as the mockingbird made considerable use of multiflora plantings, it was the seasonally and locally abundant species, primarily robins and cedar waxwings (see also Taylor, 1949; Davison and Grizzell, 1961) that accomplished massive seed movement and deposition.

Within the distance limitation of effective dispersal by birds, multiflora volunteers might be found anywhere that conditions were adequate for seed germination and survival. These circumstances occurred primarily on disturbed soil or in sparse vegetative cover where moisture and aeration were favorable, where obstructions or land management practice prevented effective interference with survival, and wherever terrain features or culture provided attractions frequented by the fruit-eating birds. The requirements might be summarized as: source, attraction, birds, seed bed, moisture, opportunity, and time. Not all such sites were occupied, of course, since as Thompson (1939) points out, plant dispersal is a kind of organized random process, if such a paradox may be imagined. Elapsed time and intensity of dispersal are important determinants in the developing process.

Multiflora volunteers were *not* usually found on sites where the ground was frequently plowed or heavily disked; where it was too wet or too dry; where a dense grass cover was combined with frequent mowing, grazing, or both; or at greater distances from a major seed source. Volunteers were found widely scattered in wooded areas, but not in abundance or with an aggressive pattern of growth.

One of the questions frequently asked is how much of an area in total will be affected by the spread of multiflora. Patuxent experience gives some indication. Multiflora was artificially introduced originally to 54 of the 1070 study plots of 2½ acres each, into which the area is permanently divided; *i.e.*, about 5% of these area units were originally infected in the epidemiological sense. We did not inquire into the entire pattern of multiflora distribution, but we can say that multiflora volunteers are known to occur now in *a minimum* of 154 of the total plots—a proportion of nearly 15%. Since at least 20 of the plots are totally covered with water, and other culture or untenable habitat occupies much additional area, the actual proportion of potential habitat known to be invaded is considerably higher. In addition to spreading within the original plots, *at least* 100 new plots have been invaded and the number of plots *known* to be infected has at least tripled in 15 years under good ordinary farming practice with an eye to wildlife values. Most of the significant spread, in other areas as well as Patuxent, seems still to be traceable to original artificial sources rather than to appreciable secondary spread from adventitious stands. This may well change as time goes on.

On the Patuxent area, 15 years of opportunity resulted in abundant spread along many roadsides and ditches, in an orchard, along fence lines (both existing and removed), in contour hedges of other shrubs, and very objectionably on the mowed banks of a farm pond. Roses also appeared in ornamental plantings, on hay pasture land, in tilled land where there were obstructions to the use of power equipment, and in a great variety of idle areas. Well established volunteers were found in densities up to seven plants per square meter in the less vigorous portions of a permanent hay field that had been fertilized, mowed and harvested at least once each season since being plowed and seeded 7 years previously. In addition, the aggressive thorny growth of mature plants created a nuisance around gates, culverts, paths or other areas of activity, and tended to round out field corners and increase the width of hedges in the direction of the sun (Figure 1).

Only a most tolerant and bird-loving landowner would not have been displeased with the behavior of multiflora at Patuxent. But was this completely atypical? Arthur Carhart (1963) has suggested that we should not overlook the Bible in seeking ecological perspectives. As it happens, there is a doubly pertinent passage in Matthew 7:15-20:

> Beware of false prophets, who come to you in sheep's clothing but inwardly are ravenous wolves. You will know them by their fruits. Are grapes gathered from thorns, or figs from thistles?

Figure 1. A mature multiflora hedge on the Patuxent Wildlife Research Center.

> So, every sound tree bears good fruit, but the bad tree bears evil fruit. Every tree that does not bear good fruit is cut down and thrown into the fire. Thus you will know them by their fruits.

Besides containing an historic reference to ancient woody weed control practices, this passage warns us that first appearances may be deceptive, and clearly recommends a pragmatic approach to such problems.

Let us then pragmatically examine what has actually happened on a larger scale, and let events speak for themselves:

Item: A resource agency in Illinois reports a neutral stand in a current "tug of war between two crusading cliques," one "pushing" multiflora, and the other "concerned with destruction of this plant which they consider a nuisance."'

Item: A midwestern technical official reports spreading problems in eight of nine States, and the bulldozing out of hedges in several different States.

Item: On a large reservoir watershed area in Maryland, land management authorities interested in multiple use and trespass control halt all planting of multiflora and express regret that they had ever planted any. Elsewhere in the State, hedges are burned and bulldozed out on some farms.

Item: Individual technical agencies in several States issue restrictive policy statements to guide field personnel. In another State a proposed statement is rejected by an advisory committee as being too mild.

Item: Top resource management officials in Ohio find it necessary to agree on a multiflora policy, and issue a public statement warning that due to its spreading habits multiflora should not be used within 3000 feet of a variety of vulnerable habitats, and that any landowner to whom multiflora is recommended shall be made "fully" aware of its spreading habits.

Item: The amount of multiflora hedge on the land in West Virginia is currently reported as being *reduced* by perhaps five times the annual planting rate each year.

Item: A Bill (House No. 3315, 1963), sponsored by a farmers' organization, is introduced in the Connecticut legislature "to prevent the further use of . . . rosa multiflora in the State." Similar legislation is suggested by an Indiana resource official.

Item: Soil Conservation Districts in parts of New Jersey adopt specific policies of "no more multiflora."

The above list is only a partial summary of the reactions that *have occurred.* These were the fruits of actual experience, and they span the range of states in which multiflora has been used in quantity. With these and other such events now a matter of history, it doesn't seem necessary to debate whether multiflora will become a nuisance, whether it is an exception or the rule, or whose fault it is when it does happen. The question is not does it really spread badly, but how do we account for it, and what do we do about it now that we have seen it happen?

The first step in understanding multiflora spread will be to call the plant a weed, and think about its performance as such, rather than as an unfairly maligned landscape shrub. This should not be a damaging concept in itself; some of our most useful wildlife plants are weeds. But sometimes what we call a thing has considerable effect upon how we appraise it. Psychologists tell us that both past experiences and induced expectations have a profound influence upon how we perceive reality, the judgments we make about it, and the actions we take as a result. This may explain why one observer will see an example of spreading multiflora as a sinister threatening weed problem, while another, viewing the same situation but conditioned by different expectations, may report nothing to worry about. As Emerson said, the difference between landscapes may be small, but there is a great difference in observers.

The Weed Society of America defines a weed as "a plant growing where it is not desired." A tomato plant is a weed in a corn field, and for some purposes, the worst weed in a corn field is corn. A British symposium (Harper, 1959) settled for "higher plants which are a nuisance." As to which plants these are, Bailey (1907) cautioned us that weeds are not characterized by species, but by habits and adaptabilities.

Plants commonly recognized as weeds tend to share certain attributes in addition to their habit of appearing in the wrong place at the wrong time. Harper in the above mentioned discussion summed these up under the label of "opportunism," which was seen generally to consist in high seed output, efficient dispersal mechanisms, and effective survival capabilities. Along with these must go adaptability to the range of environments in which the plant must thrive, and access to the types of habitat to which it is suited. How does multiflora fit this picture of weed potentialities?

Wulff (1943) emphasized that but a very small porportion of all introduced plant species naturalize successfully enough even to survive and compete in the wild state, to say nothing of becoming a pest. But multiflora had a lot going for it already when it was selected for use in conservation plantings. It had been in this country since before 1868 (Rehder, 1927), had successfully entered into may horticultural hybrid varieties, and was known as a plastic species genetically. It was being used for rootstock by rose growers because of its ease of propagation, hardiness and other conveniences (Shepherd, 1954). It had proven adaptable to many environments, and had been shown to persist well in the field (Steavenson, Gearhart and Curtis, 1943).

The history of its origin was also in its favor. It was native to Japan and a wide variety of other deciduous-forest podzol areas of eastern Asia much like those of eastern United States (Good, 1964). Its range fell within regions of remarkably similar agro-climatic analogs (Nuttonson, 1947, 1949). The principal difference was that in addition to being limited in its native range by an unspecified complex of natural enemies with which it certainly co-existed, it had evolved successfully in competition with many similar roses and other shrubs in the probable center of their ancestry (Lindley, 1820). It had also managed to persist successfully in that area of the world which has been under continuous human cultivation for perhaps the longest period of time, and in the face of some of the most intensive land use on earth (Wilson, 1927). In at least one flora (Steward, 1958), the Chinese common name for multiflora is translated as "wild rose." This plant had been in training to become a pest; all it needed was the opportunity.

In reviewing the history of invasions, Elton (1958) has concluded that the greater the complexity of the natural community, in terms of number of species and number of interactions between species, the less likelihood there is of a successful noxious invasion. Slobodkin (1961) points out that, in contrast, agricultural land is normally occupied by only a few species and is an extremely simple environment from this standpoint. McAtee (1941), in one of the first discussions of plants useful for farm wildlife, also warned that for the purpose of designating plants out of place, ". . . when the use of a particular tract of ground may vary so greatly and so rapidly as is often the case in farming operations, it becomes difficult to define just what constitutes being out of place." Multiflora's opportunity as a weed came when the plant was taken out of the cloistered nursery setting and given every possible assistance in colonizing benign agricultural environments almost anywhere that it would grow.

In the early days of the planting program people learned that many of the specific sites they had picked for multiflora were not necessarily those where it could be established easily. But most large areas contain many suitable niches, or on occasion large tracts, where the rose will grow readily without help if there is a chance for the seeds to get there. Here is where one of the unique biological advantages of multiflora stands out; it has both superabundant seeds and a way to get them there.

Few shrubs bear so many seeds so conveniently packaged and attractively displayed for distribution by birds. These are not a favorite for most birds summering within its range, nor do they ripen and stand out as a bright red attraction until autumn. But through the winter and early spring, after other fruits are gone, the rose hips are still in place, ready to attract flocks of cedar waxwings, as Schmid (1958) describes, or to sustain large flocks of robins when the worm-hunting is not good on adjacent fields. Wet places in pastures, or cattle feces, act both as seed beds and as attractions for birds that have consumed the pulp of the fruit and are disposing of the hard seeds; still more seeds are dropped near bird perches and in other heavily frequented areas. These seeds are perfectly capable of germinating, as Kerner (1902), Obraztsov (1961) and our own experiments have shown, and the normal germination rate for multiflora seeds is high (Semeniuk and Stewart, 1962). Dr. Stewart also tells me that removal of seeds from the fruits by birds in winter or early spring permits after-ripening and germination to proceed that same season, rather than being delayed until after the seed has dropped from the plant and experienced another winter of exposure with all the attendant possibilities for destruction by rodents or other factors.

One should not underestimate the efficiency of bird dispersal as *the* method of seed dissemination for certain plants. The ubiquitous occurrence of poison ivy and other such zoochores (McAtee, 1947) is a good reminder of how well it actually works. Under some circumstances, cattle may also browse on the rose hips and effectively disseminate viable seeds, as McCully (1951) has demonstrated with Macartney rose. We do not know how long the hard seeds may retain their viability in the soil after being distributed, but this feature is usually a characteristic of successful weeds.

Other woody species in farming areas also go about their busness of seed dispersal as opportunity permits. But they do not have the advantage of strategic location, massed seasonal attractiveness to birds, horticultural encouragement by the landowner, or sponsorship by conservation agencies. Things have been different for multiflora here in the United States, not only in comparison with native species, but in comparison to its original home.

John Creech of the Agricultural Research Service tells me that during his botanizing in Japan he has never seen multiflora rose (or even Japanese honeysuckle) growing as a pest or showing any signs of aggressiveness, even where the opportunities appeared good. (This in contrast to our honey locust which he reports is threatening to become a pest where introduced in Japan.) No doubt a native wild rose persisting on an individual plant basis in a competitive environment is in a situation radically different from our hedge plantings. And we do not know what complex of natural enemies may exert a limiting influence in its native range.

We have discovered here one naturally limiting biotic agent that may sometimes have considerable influence, in its absence more than its presence, upon the spreading capabilities of multiflora. The relationship has not yet been studied extensively, but I will mention it here so that it may be considered where appropriate. The organism involved is the European rose seed chalcid, *Megastigmus aculeatus* (Swederus), which is native to the original range of multiflora, and which has been locally distributed elsewhere in the world with shipments of rose seeds. Milliron (1949) and Balduf (1959) give the best available accounts of this group, and Weiss (1917) reported on its early appearance in New Jersey where it interfered with propagation of multiflora from seed. Robert Stewart, of the Agricultural Research Service, drew our attention to this organism when he found it interfering with his seed experiments.

This insect is a member of the Hymenoptera, and of the parasitoid chalcid group which has contributed other species presently used successfully in various biological control activities (DeBach, 1964). It is, in effect, host-specific to multiflora. The adult forms are minute, weak flyers with a limited life span. They deposit eggs in the developing rose seeds within the growing hips in May and June. Larvae subsequently develop, consume the seed embryo, then go into a prolonged diapause over winter. With warming temperatures in the spring, they pupate briefly and then emerge from the seed as adults to resume the cycle. The hips are unaffected, and the seeds show no signs of damage prior to emergence.

We cannot say what an average rate of seed destruction might be in a chalcid-infested hedge or how it might fluctuate. Evidence does suggest that rates of 50% or more might readily occur, and we have found it in rates as high as 95% in one sample taken at Patuxent. This may be completely atypical, but the hedge environment would be conducive to maximum sustained incidence of the organism once it was established.

The suggestive thing about this relationship is that the insect would seem normally to be disseminated over long distances only as the larval form in seeds. Since most multiflora conservation plantings were established vegetatively at considerable distance from the nurseries, my hypothesis is that a substantial proportion of them must have become established, at least initially, without their natural chalcid limiting agent. Records of distribution of the insect in this country are sparse and scattered, and inquiry to the State Entomologists of several States has revealed little additional evidence of its occurrence. I will not go further with speculation here, but should point out that the absence of even 50% seed destruction would mean a 100% increase in seed production—certainly a factor to consider.

This has led us to the question of control methods. Some assert that multiflora control is no problem; others consider this *is* the problem. Here again we have conflicting reports that it is easy to kill (these were repeated frequently in the literature), and that it is not easy to kill. Fletchall and Talbert (1960) found that it was not.

As background, we should reflect that roses as a group are distinguished by a marked ability to regenerate from remnants of the canes, or from the fleshy rootstock and crown, as anyone who has pruned or transplanted them appreciates. The result is that an initial "top kill," whatever the mechanism and no matter how complete, can be meaningless with this plant group.

At Patuxent, we have cooperated with Harold Kerr, of the Crops Protection Research Branch, Agricultural Research Service, in conducting trials of seven different herbicides and a variety of mixtures and methods of application on multiflora plants both in and away from hedges. These studies are not yet complete, but Dr. Kerr presents the following interim chemical control recommendations based on this experience and a consideration of current economy and safety factors:

> Control multiflora rose with a foliage wetting spray applied between the time of budding to full blooming of the plants. Use a spray mixture containing 1 pound acid equivalent each of 2, 4-D and 2, 4, 5-T in 100 gallons of water. Either water soluble amines, oil soluble-water emulsifiable amines, or low volatile ester formulations may be used. However, if water soluble amines are chosen, the spray mixture must contain 10 per cent kerosene or diesel oil and ½ per cent dish washing detergent on a total volume basis. Apply the spray at a pressure between 100 to 200 psi in order to make the spray penetrate into the inner canes and foliage. Drenching the plants is not necessary but all foliage should be wetted.

Killing a hedge may be the simplest of the control problems, but in any case the timing and thoroughness of application are important and the landowner should be prepared to repeat applications in successive years if necessary. Some of the newer or more persistent chemicals, such as Picloram, 2, 3, 6-TBA, and Dicamba, gave excellent results and may be used effectively in appropriate circumstances conforming to label requirements. From the standpoint of wildlife values, we recommend treatments that permit early regeneration of other broad-leaved plant species—especially where hedges are killed. Patuxent experience suggests that if the dead hedges are left in place to supplement pasture fencing, they will continue to provide food and cover as seeds brought to the hedges by wildlife provide a new sequence of vegetation growing up through and over the dead rose canes. Stands of wildlife food attract carriers of wildlife food seeds, and plants disseminated by birds tend to be those useful to birds. The greater variety of secondary vegetation that develops may in some ways be even more desirable for wildlife than the original rose monoculture.

Control of spread by ecological means can range from the obvious decision not to plant rose in the first place, through varying degrees of care in planning patterns of land use so that negative factors are brought into maximum conjunction near rose plantings, and so that the recognized features encouraging spread are kept to a minimum or at a distance. Foresight is important; experience has shown that by the time a landowner recognizes his spread problem it has usually proceeded too far to be prevented or easily corrected.

Many people want to know *how many* of these landowners have found multiflora a nuisance. Vagn Flyger and Theodore Bookhout, of the University of Maryland Natural Resources Institute, in 1963 obtained some preliminary data bearing on this question. In pre-testing a personal interview questionnaire, 43 farmers in 11 of the state's 23 counties were interviewed to get their appraisals of the multiflora on their land. The sample was neither selected nor randomized in any particular fashion, and any systematic bias involved would probably tend toward favorable reports. Of the total interviewed, 30% had definite complaints. About 15% were equivocal. In about two-thirds of the sample, from the inland portions of the state, almost 50% of the farmers had complaints. At least one was bitter about having been misled and wanted help in eradicating all the rose from his property.

I do not go into specifics with these figures, nor stress the proportions involved, because I wish to emphasize how *unimportant* are the actual numbers. Here was just one more illustration that there *is* an appreciable proportion of landowners who *are* dissatisfied, and that dissatisfaction does grow to include bitter disillusionment. Does anyone believe that the proportion of complaining landowners must reach 51% before it means anything? We should once and for all dispense with the empty assertions that "many farmers like it," in contrast to: "many farmers dislike it." Both statements are true, but they leave us with an argument like trying to decide wheteher a container is half full or half empty. The challenge to ecologists is not to find takers, or administer an election, but to exercise their scientific judgment.

Elton (1958) wrote about invasions as "ecological explosions," using the latter word because it means "the bursting out from control of forces that were previously held in restraint by other forces." He said these differ from the other explosions in our modern world "by not making such a loud noise and in taking longer to happen. That is to say, they may develop slowly and they may die down slowly; but they can be very impressive in their effects, and many people have been ruined by them . . ." It would be well to remember that the dissatisfaction with multiflora grows and spreads slowly just as has the realization of the spread problem, and that events recorded so far as probably only portents of things to come.

When a farmer develops a dislike for multiflora it is no sometime thing. The plant is large, overbearing, brutally thorny, and seemingly immortal. A dense clump of multiflora 30 feet through with 12-foot long sweeping canes on a stem 4 or 5 inches thick is not easily ignored, and this is the potential he may see in every volunteer he doesn't individually destroy. Here are the slightly censored remarks of one of the first landowners I talked to:

I'll testify about multiflora. Oh Brother! Was that a mistake! . . .

> They talked me into planting two hedges on my place for living fence and wildlife. I took good care of them and they were really growing fine. Then I saw the birds were feeding on them, and wherever they dropped the seeds, multiflora was springing up and I could see it was going to be a problem. So I killed the hedges, rooted them up, and got rid of them. First I sprayed to kill them, then sprayed again to kill them, then sprayed with coal oil and burned them, then I plowed, and pulled, and cursed, and finally got rid of them. Now I have to go out and spray every year wherever they appear over the whole farm. The plants will turn brown and so on, but it don't always kill them. Its an endless job, and now its coming up on the neighbors' farms, and they're unhappy too. It's bound to get away—it'll be as bad as mesquite in Texas. Its the most dangerous thing that's gotten out since the first sparrows were brought over.

These disillusioning experiences will neither go away nor be forgotten, nor will our reaction to them be unnoticed or forgotten. It would be reassuring to be able to report, as in Wisconsin (Kabat & Peterson, 1963), that "opportunity for criticism by private landowners that public agencies are not agreed in word or practice on weed control and brush management has been greatly curtailed."

Perhaps the best way of summarizing all the foregoing discussion is by taking advantage of what someone called "the exquisite acuity of hindsight" to pose a not-so hypothetical question. Let us pretend that we are considering selecting and promoting a useful shrub for conservation plantings. This will be our baby and we will stand behind it. We find a species that has a long list of obviously desirable attributes, but the biologists involved, being intelligent, well trained and ethical men, realize they must closely examine the disadvantages too. They remember previous sad experiences with introduced exotics, and realize that disadvantages sometimes must be regarded as disqualifications. They remember the need for public confidence in their judgment and integrity, and reflect that if their science and technology is as advanced as they would like to think it is, then the technical people should be able to agree on whatever is decided and remain alert to how it turns out. They know, too, that it is almost impossible to do just one thing in manipulating an environment.

The big question with an introduced plant is whether it will become a pest. They know that measures for farm game must be made a matter of agricultural practice, and that anything suggested must be harmonious with the landowner's practices and desires; not only acceptable, but preferably advantageous to him. They know most farmers feel they have more than enough to do at best, and that they must anticipate how things will actually work out in practice—not just how they intend them to be. They realize it is the landowner who will decide whether he has a pest or not; that in the pattern of injurious plant laws a man is held responsible for what grows on his land; and that a man who introduces a nuisance plant that will spread and injure another's property might also be liable in court for constructive trespass, nuisance, or negligence.

They know that agricultural lands are a relatively simple, noncompetitive environment, and that the patterns of land use, and even ownership, have a habit of changing. They realize that idle land is a common occurrence in normal operations, and that it is sometimes encouraged by public policy.

They are reminded that the weed problem is one of the costliest in the agricultural picture—to the consumer as well as the farmer—and that you cannot legislate or admonish against a vacancy in nature. They have long realized that the best way to control weeds is not to have them, and these days they are consciously trying to avoid adding to the reasons for pumping toxic chemicals into the environment. Above all, they don't want anyone to regret having followed their advice, or to resort to clean farming as a result of it.

So they review the plant characteristics and environmental conditions that they know will permit a plant to become an objectionable weed, and compare these to what they have learned about the candidate plant—which we might call *multifuror ruse*. From experience they know for sure there are two situations where this plant will not cause any trouble; where volunteers are regularly plowed under, and where it is not planted at all. But the main problem is all those seeds being scattered around. Would a seed parasite like that chalcid that is supposed to go with it make any difference? Would chemical solutions be solutions to the problem, or only symptoms of a problem? There must be some places where this plant would not be a nuisance—even in the future. Could they recognize such places and just let it out there? It is a handy plant—even highway departments are using a lot of it, and a lot of nurseries sell it . . . "Anyway," murmurs someone, "its the only game in town."

What *do* they conclude?

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DISCUSSION

CHAIRMAN PETERLE: Multiflora rose has been cussed and discussed probably more than any of our recent wildlife habitat improvement programs. As managers, we have gone from spending a great deal of effort in trying to learn how to grow more and better rose by fertilization, genetic selection and publicity to evaluating methods for controlling the growth by mowing and use of pesticides.

VICE CHAIRMAN SADLER: It occurs that the multiflora rose has won the academy award. It has joined such illustrious weeds as ragweed and smartweed, wild grape and timber and, of course, to some foresters, this is certainly a weed species. Then, probably one of the worst, at least in the Midwest, in cultivated row crops is Giant Foxtail and Giant Foxtail is one of the better quality foods we can find.

Bob, as an investigator, would you sum up the pluses and minuses? In other words, do you think the pluses are greater or lesser than the minuses?

MR. SCOTT: I would rather say "no comment" to that because I think every situation is different. I do believe, from the standpoint of public image of the technical people, that we can ill afford at least to have a large segment of our population, people we depend on for cooperation, to feel that they have been misled. I think with the value of the multiflora over the long run, it would be difficult for anyone to say whether or not this might be very crucial and very important in survival of the population in extreme conditions. I don't know whether anyone has been able to measure this. I am afraid that the disadvantages right now amount almost to disqualification and I would say, as I said in the paper, there are some control recommendations from Dr. Kerr of the Agricultural Research Service and that we expect chemical control could be accomplished if it is desirable to make this a part of the landowner's practice.

DR. DAVE KLEIN (Alaska): You have outlined the problems very effectively. What course of action is now ahead? It seems to me that technical and policy changes are involved here. Therefore, what course of action do you suggest or outline?

MR. SCOTT: Well, if I were a state employee and an administrator called me in for my advice, my words to him would probably be that the most important thing for us to do is face up to reality and instead of tacitly implying that multifora is all right, that we make it quite clear to all of our clients—the public—that we feel multifora is a dangerous plant to use and it should only be used under certain circumstances and that these would be the exception rather than the rule.

MR. OREN (Department of the Army): Did you find this to be true on well managed type of land or well managed woodland? On well managed land, is plowing and everything else done normally on that kind of land taking care of it?

MR. SCOTT: Well, if you put it as a question of "well managed," it is a question of the kind of culture. It is also a question of whether the ground is being plowed up or disced. Here, of course, multifora will not survive and, further, it does not survive aggressively in woods of most any type. However, there are many places where under really good farming practices. there are niches for multifora to grow. I would rather say that almost anywhere you do not have frequent plowing, discing, or where you do have the type of pasture that does not have a dense, vegetative cover, you should expect it.

ASPECTS OF ANIMAL MOVEMENT AND HOME RANGE DATA OBTAINED BY TELEMETRY

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A full understanding of the ecology of any animal entails knowing the animal's movement patterns. Because the movements of animals are frequently difficult to observe under natural conditions, most data have been collected by indirect methods such as trapping and marking or studies of tracks or signs. A comprehensive review of such techniques and of types of data analysis has been prepared by Brown (1962). Recently developed telemetry techniques for tracing movements of animals have provided excellent data for evaluation of standard methods of data collection and for theoretical considerations of the concepts of home range and movement.

This paper considers the concepts of center of activity (Hayne, 1949) and activity radius (Dice and Clark, 1953) in light of telemetry data. The effect of sampling interval on distance traveled and area used is discussed and the Poisson and geometric are examined as possible distributions to approximate the use pattern of the home range.

Data for our analyses were obtained at the Cedar Creek Natural History Area in east-central Minnesota by an automatic radio-tracking system (Cochran *et al.*, 1965) which continually monitors movements of animals carrying miniature radio transmitters. The radio signals are received by rotating antennas supported on two towers spaced 0.5 mile apart. After amplification and conversion, the signals are fed to a 52-channel receiving and recording system located in a laboratory between the towers. Time and bearing data for up to 52 animals are continually recorded on 16-mm. film. An operator using a microfilm reader takes bearings from the film as desired and determines locations by triangulation. The mechanical accuracy of the system is ± 0.5 degrees.

A digital-computer program has been developed for automatic map construction and distance computations of animal-location data obtained by the automatic system. This program is adapted to the University of Minnesota's CDC 1604 computer in connection with a CDC 160A that furnishes instructions to an x-y plotter for map construction. A discussion of the program and a flow diagram showing basic aspects of the computations are presented by Siniff and Tester (1965). Modifications of this basic program provide methods of analysis concerned with the center of activity and the distribution of the activity radii.

The data for these discussions are from an adult male raccoon (*Procyon lotor*) which weighed 26 pounds when captured. He was judged to be "old" because of severely worn teeth. The animal, designated as Raccoon 603, was captured, equipped with a transmitter and released on October 9, 1964. Under optimum conditions the tracking system monitored his location at 45-second intervals.

For the analyses reported here the triangulation locations are assumed to represent the actual location of the animal at the specified time. We believe that this assumption is acceptable for theoretical considerations. However, we realize that the calculated path and distance traveled do not represent the real conditions. The following discussion examines the possible errors in this assumption.

Normally we read film records only to the nearest degree. Regardless of where the animal actually is, we assume it to be at an intersection of two bearings. The amount of error thus introduced varies depending on the distance from the towers and the position of the animal with respect to the base line between the two towers. Raccoon 603 was generally in "good" position except when in the northeast corner of its range where the fixes are spaced farther apart. We believe this is due to close proximity of this area to the base line.

Another bias occurs when obtaining a fix on a moving animal. A time lag of up to 22½ seconds may exist between recording of the bearings of the two towers. During this time the animal may move a considerable distance; thus, the intersection does not represent a true location.

We do not know what these errors may do to the distributions of the fixes within the home range. The overall outline of the home range is probably nearly correct; however, these errors may cause the recorded locations to be spread out more within the home range than is actually the case. The radio-tracking data do provide an estimate of the distance traveled, and as the number of fixes increases they tend to fall around the actual path of travel. The observed distributions to be discussed are probably affected only slightly by these factors, and we mention them only to give some insight to problems existing in telemetry studies.

SAMPLING INTERVAL

The ideal of one fix every 45 seconds is seldom achieved because of interferences and transmitter limitations. In spite of these limitations, the question of how often one should attempt to obtain a position needs to be considered. The answer lies largely in the objectives of the study, e.g., whether one is investigating general home-range patterns or minute-by-minute movement. In the latter, comparisons between individuals for specified periods are often desired so that movement differences between sex and/or age classes can be evaluated. In such cases the total distance traveled as computed by the straight-line distance between fixes (Siniff and Tester, 1965) during some specified period would be useful.

Positions were obtained every minute for the study animal during portions of the nights of November 15 and 16, 1964 to determine the effect of various sampling intervals on total distance traveled. In all, 259 fixes were obtained, but within these data four periods occurred when it was impossible to obtain a position every minute. These breaks were 873, 27, 73 and 136 minutes in length. The blocks of one-minute fixes were sampled and total distance traveled was computed for 1-, 2-, 3-, 4-, 5-, and 10-minute intervals (Figure 1).

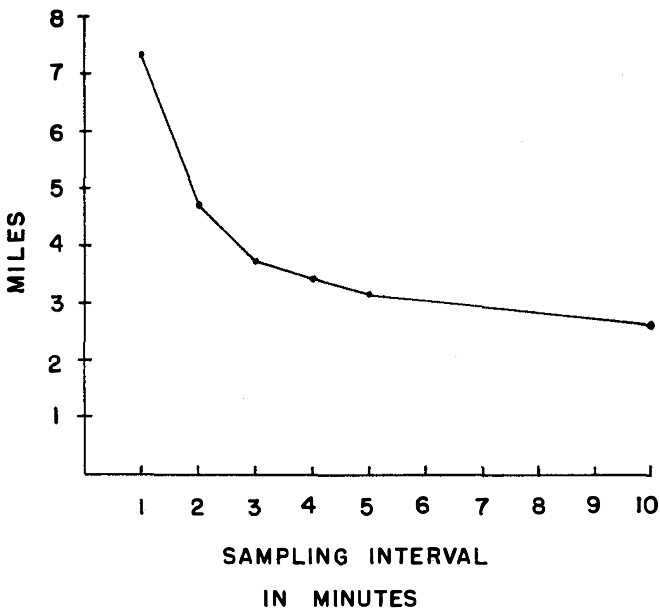

Figure 1. Relation of sampling interval between fixes to total distance traveled computed as the straight-line distance between consecutive fixes for Raccoon 603, November 15-16, 1964.

The computed total distance traveled is dependent on the sampling interval one chooses for a given block of data. The overall effect seems to be one of smoothing an irregular path as the sampling interval becomes longer. However, there are other complications and a full evaluation is needed. The effect of our one-degree reading error on the total distance traveled is proportionately greater when the sampling interval is small. In the case of a small sampling interval this error contribution may be greater than the actual distance traveled; as the sampling interval becomes greater the effect of the error is masked by the smoothing effect. At this time the computed distance probably becomes less than the actual. The magnitude of the contribution from error for a particular sampling interval is uncertain at this time. Determination of this contribution is influenced by the bias introduced by obtaining a position when the animal is moving. We believe that the magnitude of this bias increases with speed. Since sex, age and species probably influence the speed and extent of movements, this bias may differ for each group and perhaps for individuals within a group. In addition, the biases derived from positioning relative to the towers must be considered.

Our interest at present is to choose some interval which will reflect distance traveled by an individual so that comparisons can be drawn between sex and/or age and also between species. In spite of the previously mentioned biases we feel this is possible. It appears that the proportion of error introduced decreases as the sampling interval becomes longer; however, we do not know how long the interval can be and still reflect the animals' movement. Since there are difficulties in obtaining fixes every minute and in light of the error discussions, sampling at 5-minute or longer intervals is indicated at this time for movement comparisons.

The effect of sampling interval on the shape of observed area used is also important. Figure 2 shows the movement pattern at one-minute intervals as compared to ten-minute intervals as drawn by the computer. The overall shape is relatively constant but the plotted path becomes less erratic for the ten-minute-interval map.

CENTER OF ACTIVITY

Various methods have been derived to study the home-range patterns of animals. Hayne (1949) reviewed the concept of home range and considered patterns of use in meadow voles (*Microtus* sp.) in terms of the distribution of recaptures from the geometric center; he called this location the center of activity. Dice and Clark (1953) expanded this concept by computing the recapture radii from the center of activity for the deer mouse (*Peromyscus maniculatus bairdii*). They were interested in the theoretical distribution which best fit the distribution of recapture radii and tested for comformity to a Pearson Type III probability function. They found significant differences between the Type III distribution and observed data.

Calhoun and Casby (1958), using data on harvest mice (*Reithrodontomys* sp.), also studied the distribution of radii from the cen-

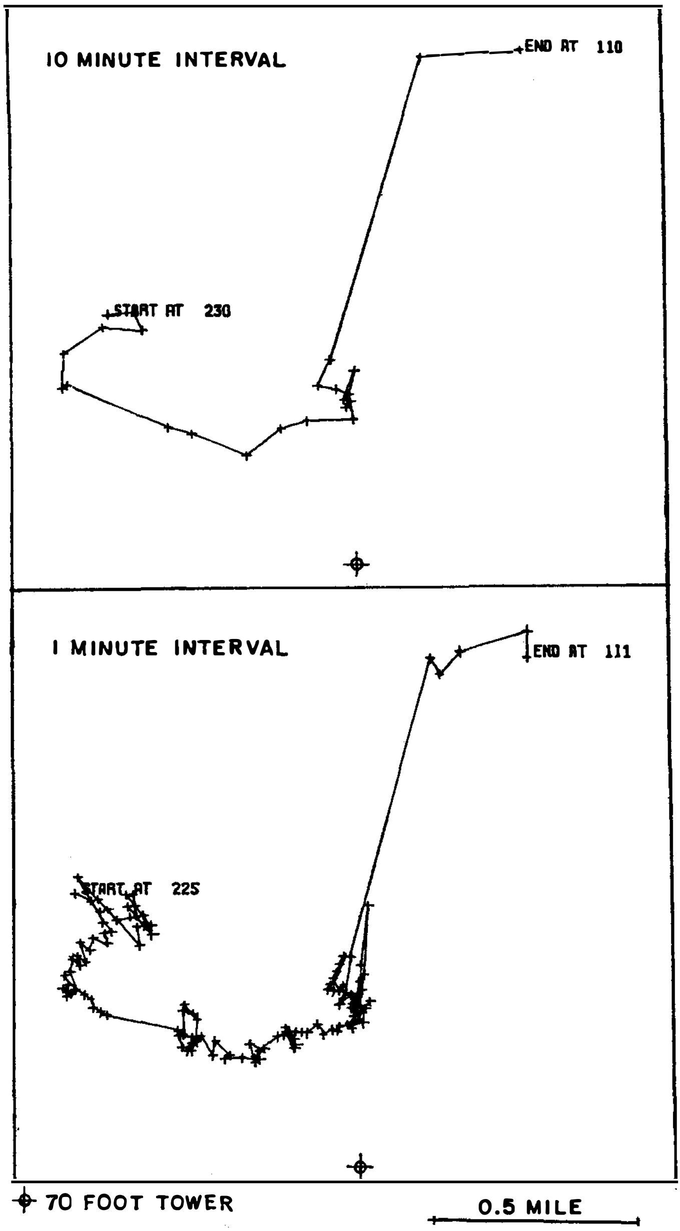

Figure 2. Movement of Raccoon 603 on November 15 and 16 comparing 1-minute and 10-minute sampling intervals between fixes. The maps are based on 259 and 27 fixes, respectively.

ter of activity. They proposed that a circular normal distribution might best fit such measures of home range. The circular normal, like Pearson's Type III distribution, assumes that the probability of an animal being in a particular area decreases with increasing distance from the center of activity.

Eberhardt *et al.* (1963) considered similar problems in relation to the frequency of recaptures in a cottontail rabbit (*Sylvilagus floridanus*) population study. They found that the geometric distribution best fitted recapture data and used this distribution to estimate the frequency of individuals not captured at all. Summing the expected frequencies, in this case, suggested a method of estimating population size. Various problems concerned with the meaning of such totals in terms of the actual population of rabbits were discussed.

These papers provide a useful base from which we can pursue the concept of home range as derived from the radio-tracking data. We believe that the center-of-activity and activity-radius concepts may be very useful in intra- and inter-specific comparisons, as well as in evaluating changes in behavior of an individual animal in time. A modification of the computer program presented in Siniff and Tester (1965) makes possible rapid computation of the center of activity and the distances of the positions from the center.

For purposes of this study we have obtained fixes from October 13 through 18 and November 7 through 17. When possible, positions were obtained every five minutes from the time the raccoon started moving in the evening until he stopped the following morning. Thus, the sample size varied between nights but in general each sample represented data distributed throughout the entire evening's movement. To alleviate the problem of undue weight to a position where the animal may have stopped for several hours, a fix was included only if it was different from the preceding one. Any change in bearing was considered as a different fix. These data, consisting of 157 fixes from October and 364 from November, are used in all of the following home-range considerations.

The number of locations required to estimate accurately the center of activity of a home range depends on the temporal and spatial pattern of the animal's movements. Raccoon 603 moved over only a portion of his total area of use each day. Figure 3 illustrates this type of movement for November 7, 8 and 9 (Maps A, B and C) and shows the development of the center of activity for the period from November 7 to 17 (Maps A-E). In addition, the distribution of all locations and the center of activity for the combined periods, October 13-18 and November 7-17, are presented (Map F). These data indicate that this raccoon covered most of his area of use during the study periods in about 4 days. The center of activity moved slightly as additional days' data were included but remained in essentially the same location after approximately 5 days. The October 13-18 center was located 1320 feet from the November 7-17 center.

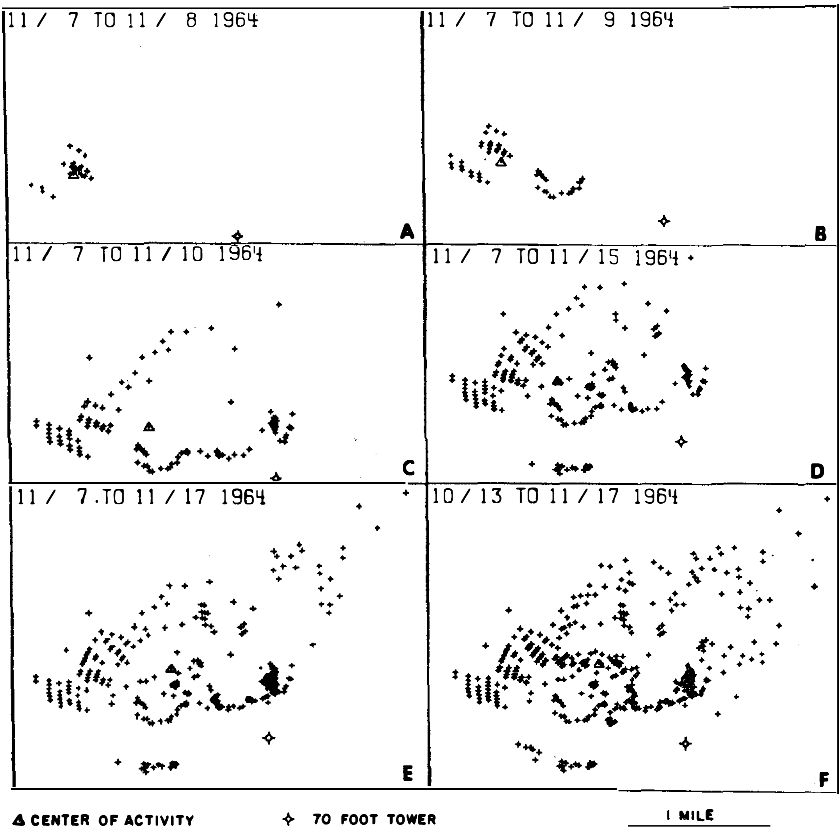

Figure 3. Locations of Raccoon 603 for selected time periods in October and November 1964 illustrating the pattern of use of the home range and development of the center of activity.

The average lengths of the activity radii for the October 13-18 and November 7-17 data are shown in Figure 4. Each point represents a cumulative daily value with sample size indicated on the abscissa. A leveling off of the average value of the activity radius for November and possibly for October is observed at four days at a distance of slightly over 3000 feet. The close agreement of the October and November activity radii and the maps showing November and combined October-November locations (Figure 3, Maps E and F) indicate much similarity in the area of use during these periods.

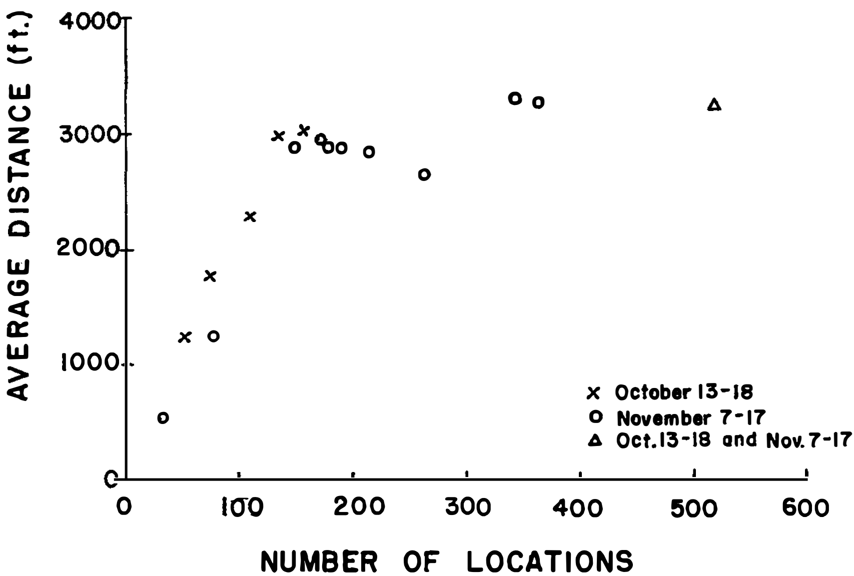

Figure 4. Relation between the average lengths of the activity radii and the number of locations for Raccoon 603, October and November, 1964.

Because Calhoun and Casby (1958) found that the circular normal satisfactorily fit their recapture data, this distribution was considered for the present data. The observed distribution of the lengths of the radii from the center of activity is shown in Figure 5. The circular normal suggests that the fixes are distributed in a circular manner about the activity center and that the probability of an animal being in a unit of area decreases with increasing distance from the center of activity. The shape of the observed home range (Figure 3, Map F) shows considerable deviation from a circular pattern and the outside edge is rather definite. Also, these data are known to contain a certain bias since the fixes in the northeast corner of the range are relatively close to the base line between the towers. Therefore, they are more spread out than fixes at the other edges of the observed home range. Because of these factors the circular normal was considered inappropriate for these data.

It is of particular interest to observe the relation of the center of activity to the actual use of the home range. The geometric center (Figure 3, Map F) does not fall within an area of heavy use by the

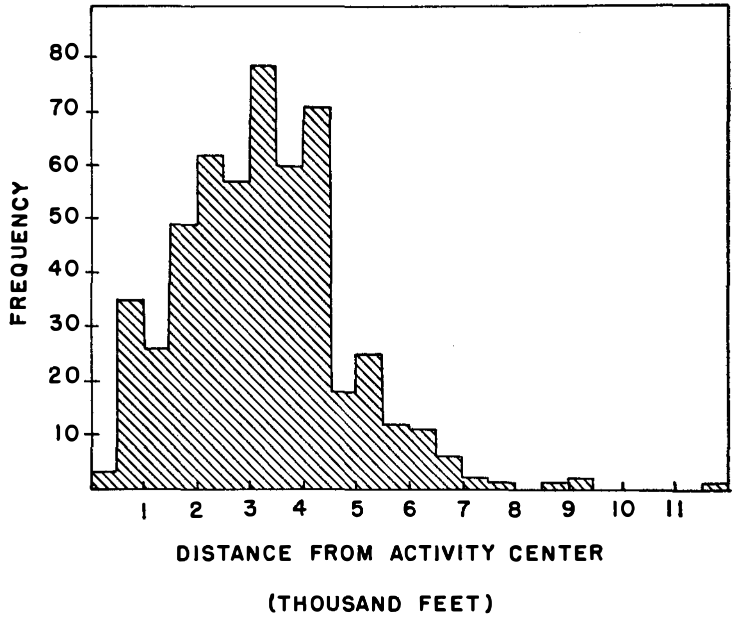

Figure 5. Distribution of 521 activity radii of Raccoon 603, October and November, 1964.

study animal and probably does not represent a place of special biological significance. This is not surprising since it is a computed value and is not even required to fall within an area that the animal actually enters. In general Raccoon 603 does not have paths to the center of activity and does not use the area more intensively than other sites within the home range. The animal's distribution of time, as suggested by the density of fixes, is somewhat evenly spread over the area; however, areas of intensive use do exist within the home range.

The daily pattern of movement is illustrated in Figure 3, Maps A-C. Considerable variation occurs in the average length of the daily activity radii (Table 1). We believe this is attributable primarily to two sources; the extent to which we were able to sample adequately the entire nightly movement, and, second, the effect of environmental factors such as season and weather on the movement of the animal. In order to separate these two sources of variation, more uniform sampling is needed. In general the daily activity radii are shorter than the cumulative monthly values—illustrating again that the animal moves over only a portion of his total area of use each day.

The distance between successive daily centers of activity is also presented in Table 1. Considerable variation again exists, but in this instance we think it is primarily a reflection of the general movement of the animal rather than a sampling factor. The data show that there is a shift in the daily activity center during autumn. In contrast, unpublished location data for this and other raccoons indicate this is not the case during winter when individuals may stay within the same den or form for many days.

TABLE 1. CHANGES IN CENTER OF ACTIVITY AND ACTIVITY RADIUS OF RACCOON 603 FROM OCTOBER 13 TO 18 AND NOVEMBER 7 TO 17, 1964

Date	Number of locations	Distance between daily centers of activity (ft)	Average daily radius (ft)
Oct. 13–14	52		1238
14–15	24	3141	1379
15–16	34	4778	2069
16–17	25	4963	1723
17–18	22	4224	2387
13–18	157		3020[1]
Nov. 7–8	37		508
8–9	42	1056	1618
9–10	71	3590	3196
10–11	24	2534	2464
11–12	6	3379	1175
12–13	10	739	1301
13–14	26	2560	2476
14–15	47	739	1429
15–16	80	5121	2620
16–17	21	4857	1951
7–17	364		3253[1]
Oct. 13–Nov. 17	521	1320[2]	3224

[1] Average length of all activity radii for specified period.
[2] Distance between October 13–18 and November 7–17 centers of activity.

Another approach to studying home range and usage patterns involves partitioning the area of usage into squares of arbitrary size and observing the frequency distribution of squares containing 1, 2, 3 . . . positions (Siniff and Tester, 1965). In this case the squares represented 1.6 acres for the data on Raccoon 603. This technique, in addition to providing information useful in acreage considerations, may also be useful for investigating how the animal spends its time within the area used.

The Poisson distribution describes a sequence of random events occurring in time. Therefore, one might expect the frequency of squares containing 1, 2, 3 . . . fixes to follow:

$$f(x) = \frac{e^{-m}m^{x}}{x!}$$

where f(x) is the proportion of squares containing x fixes (x = 0, 1, 2, 3 . . .) and m is the average number of fixes per square. However, as the definition of a Poisson indicates, the events are assumed to be random, and in the case of our data the position of a fix is dependent on the one preceding it in time. An animal must move from one point to the next and thus the positions are not independent. The fixes may become more independent and the Poisson approached as the sampling interval between fixes lengthens. Some type of random walk process may be helpful in interpreting the distribution of fixes. Even though the assumptions of the Poisson were not satisfied by these data an approximation was made (Table 2). In the observed data we have no way of knowing the zero frequency; however, the assumption was made that the model is valid and the method of fitting a truncated distribution (Hartley, 1958) was used for computing the values of Table 2. Briefly, this is an iterative process employing the maximum likelihood estimate for the mean number of fixes per square. In this case the fit is poor, as could be expected in light of the dependency of the fixes.

TABLE 2. OBSERVED AND THEORETICAL DISTRIBUTIONS OF THE NUMBER OF POSITIONS PER 1.6 ACRE SQUARE WITHIN THE HOME RANGE OF RACCOON 603.

Number of position per 1.6 acre square	Observed frequency	Theoretical distributions	
		Geometric	Poisson
1	156	131	106
2	50	65	84
3	23	33	45
4	12	16	17
5	6	8	6
6	4	4	2
7	2	2	1
8	1	1	
9	4		
10	1		
11	0		
12	1		
13	0		
14	1		

If one considers each square as a "trap" these data are somewhat like recapture data with a "recapture" occuring each time the animal is located within a particular square. Eberhardt *et al.* (1963) found that the geometric distribution satisfactorily approximated the recapture frequency for cottontail rabbits. Thus, one might expect the geometric distribution to fit our data. This distribution is given by:

$$f(x) = pq^x$$

where f(x) is the proportion of squares containing x fixes ($x = 0$, 1, 2 . . .), Eberhardt (personal communication) pointed out that the maximum likelihood estimate of p, for zero frequencies missing, is easily derived, and his suggestions were used in fitting this distribution. This estimate of p is the ratio of the total number of squares occupied to the total number of fixes and the distribution for zero fixes missing is:

$$f(x) = pq^{x-1}$$

The geometric distribution gives a better approximation than the Poisson (Table 2).

Two major sources of disagreement can be noted when the observed distribution is compared to the geometric. One is the divergence for the number of squares containing only one fix and the other is the poor fit in the tail region. The latter is probably due to the nature of the animal since there are areas within the range which are visited frequently. The divergence for the number of squares containing only one fix could be related to the problem of error. A contribution of error relatively large as compared to square size would probably cause an abnormal number of fixes to fall in separate squares. Also, this discrepancy may be related to the manner of choosing the square boundaries since squares containing one fix are probably often boundary squares. Certainly further evaluation is needed but it appears as though the geometric distribution may be very useful in this case.

DISCUSSION

Nearly continuous data on the location of an animal provide considerable insight into phenomena associated with the concept of home range. Although the information presented in this paper pertains to only one animal for a relatively short period, it illustrates what will be done with many species of vertebrates through use of the Cedar Creek automatic radio-tracking system. Application of the types of analyses discussed above to many individuals and many species should ultimately provide us with a clearer picture of how animals actually "use" the areas in which they live.

The concepts of center of activity and activity radius take on new significance when evaluated by continuous location data as compared to recapture data. We feel, in light of the discussions presented above, that these concepts can be useful in many problems of wildlife biology. Perhaps the most obvious application would be to establish a trapping-tagging-recapture study of radio-tagged animals to evaluate the effects of trap responses and the density of traps as discussed by Hayne (1949). This type of study might permit a re-evaluation of much of the published data on animal movement and home range.

Population ecologists may be able to use the distances between centers of activity to indicate total numbers of animals in a given area. The shifting of home ranges and consequently centers of activity, may have a pronounced effect on attempts to use the Lincoln Index (Eberhardt *et al.*, 1963). Evaluation of such shifts may provide quantitative information on "wandering" of certain species at certain seasons. For example, we may be able to anticipate the rate of immigration into areas of excessive hunter harvest, and we may obtain information on seasonal shifts in density.

Seasonal changes in the distribution of activity radii may be useful in selecting census methods and in the setting of the dates of hunting seasons. We anticipate that in some species that exhibit territoriality the activity radius will be relatively small during the breeding season compared to other times of the year. The determination of the activity radius may be of use in laying out census routes or in determining the width of census transects. Considerable speculation has arisen concerning the increased mobility of male white-tailed deer during the rut. Quantitative data on the activity radius during this period and on the effect of various environmental conditions on this aspect of deer behavior would be of considerable value in selecting the actual dates for shooting.

The relation of the center of activity and activity radius to specific features of the habitat may serve to point out environmental requirements of the animals concerned. Plotting of these parameters on habitat maps may suggest the need for specific patterns of cover interspersion or other habitat features which have not yet been considered in evaluating distribution and abundance of game.

SUMMARY

This paper examines the concept of home range in terms of: (1) effect of sampling interval on distance traveled and area used, (2) center of activity and activity radius, and (3) distribution of telemetry fixes within a home range. The discussions are based on location data from an adult male raccoon during October and November, 1964 at the Cedar Creek Natural History Area in east-central Minnesota. We used an automatic radio-tracking system to monitor movements and a digital computer to analyze the data. The selection of the time interval between fixes influences the total distance traveled computed as the straight-line distance between successive fixes. Difficulties in obtaining consecutive fixes and the problems of system errors are discussed in relation to choosing a sampling interval for studies where distance traveled is used for descriptive purposes. Development of the center of activity and the distribution of activity radii are considered. Home range is further analyzed by partitioning the area of usage into squares of arbitrary size and observing the frequency distribution of squares containing 1, 2, 3 . . . positions.

This distribution is compared with the Poisson and the geometric, with the latter giving the best approximation. Applications of these aspects of movement and home range to problems of wildlife biology are discussed.

ACKNOWLEDGMENTS

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METHODS FOR ESTIMATING MICROTINE ABUNDANCE

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Oscillations in the numbers of the meadow vole (*Microtus pennsylvanicus*) and of other members of this genus have attracted much interest, both from the scientific and the economic point of view. There is a large literature concerning the remarkable fluctuations in numbers of these animals, brought together by Elton in 1942 and more recently by Golley (1963) who has listed almost 1000 titles. These small rodents are common and easily studied; their periodic outbreaks may cause spectacular damage through girdling of orchard and nursery stock. Crop damage may also be substantial. The consequent economic losses, along with the scientific interest, have lead to attempts to predict the times of high numbers.

This paper reports the independent evolution of similar but distinct index methods for estimating the abundance of microtine rodents over large areas of the Midwest. Hayne began his work[2] in 1947 (Hayne, 1950) and eventually extended annual measurements over much of Upper and Lower Michigan, terminating field work in 1959. Thompson began measurements[3] in Wisconsin in 1960 and continues his program to date.

The present communication reports in a general manner on the apparent usefulness of our methods and examines one question inherent in any such study. In estimating population levels by field appraisal methods similar to these, whether in the investigation of basic population dynamics or in an attempt to predict crop damage during periods of high population, we encounter this basic question: Does a set of stations scattered throughout a region allow some statement of average population levels at other points in the same region at the same time? To answer this question fully with regard to, say, orchards would require a much larger and more costly study; however, an approximation to an answer can be reached here.

HISTORY AND METHODS

Following the work of Hamilton (1937) and others, Hayne's work was undertaken in Michigan in the hope that, by a continuing study

[1]New York Conservation Department, Cornell University, U. S. Bureau of Sport Fisheries and Wildlife, and Wildlife Management Institute, cooperating.
[2]Hayne's work was supported by the Michigan Agricultural Experiment Station except for the Fall of 1957 through 1959 when field expenses were provided by the Michigan Department of Conservation.
[3]Thompson's work was supported by the Bache Fund of the National Academy of Sciences in 1960 and 1961, Wildlife Management Institute funds in 1962 and by a National Science Foundation grant thereafter.

of the abundance of voles, it would be possible each fall to estimate the general hazard of damage in orchard country where losses can be severe during some winters. After intensive study of a relatively small number of local populations, it became clear that there was neither an absolute regularity of periodic fluctuation, nor an absolute synchrony among the populations under study. Therefore, information on the synchrony of populations in adjacent and in more distant regions was sought from a more widely dispersed and numerous set of observations, necessarily made with lesser precision. After a year of exploratory work, some 63 stations permanent to the life of this investigation were set up in the fall of 1947, extended over most parts of the southern half of Lower Michigan (Fig. 1). The number had been increased to 94 in the spring of 1951 and that fall the stations were extended into northern Lower Michigan and into Upper Michigan, raising the total to 176. By 1953, the number of stations was increased to 153 in the spring and 197 in the fall, being stabilized at this level for the rest of the study. Stations in Lower Michigan were visited both in spring (except 1949) and in fall, while those in Upper

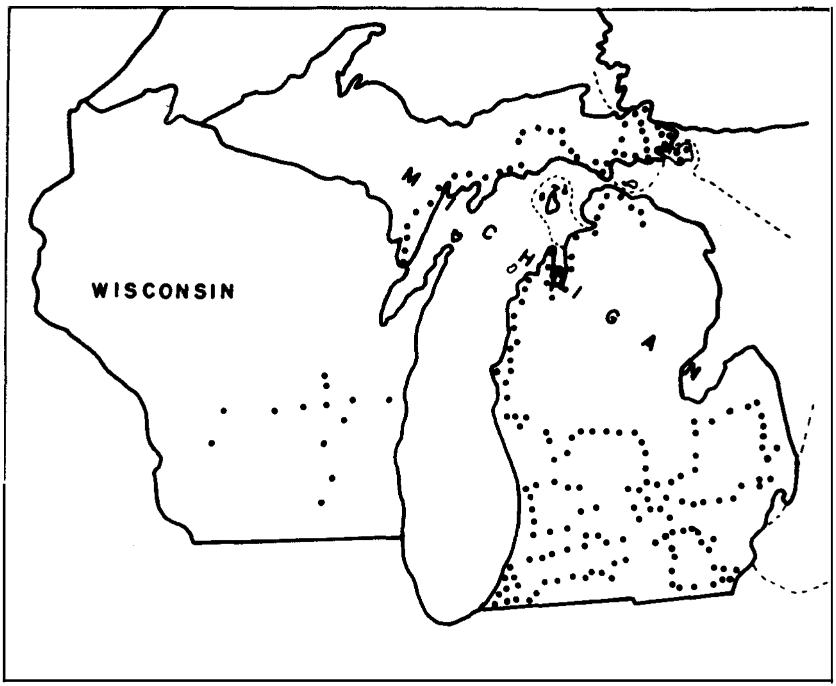

FIG. 1

Michigan were covered only in fall. The last observations were made in 1959. One observer (Hayne) made all field examinations and records.

Hayne's stations were small areas of good vole habitat selected along routes to be followed by automobile throughout the various portions of Michigan. The routes were mapped out before going into the field, choosing roads which passed through the regions to be sampled, with close attention to county highway maps of the Michigan Highway Department which furnished information on roads and drainage features. Along the routes, stations were laid out about 10 to 20 miles apart, sometimes closer. The exact station locations were chosen with attention to several factors, but foremost that the area should support the best ground cover of grass during conditions of drought. Another important factor was permanence of access, and several times the most direct route was modified to place a station on state-owned land. Other factors were safety and ease of access from the road, and relative freedom from nearby curious questioners. However, only rarely did the undoubtedly curious behavior of the investigator provoke the mildest of the questions. The stations chosen were mostly near highway crossings of drainage features where the roadside would be maintained in a flourishing cover of grass both by the adjacent moisture and by the shrub control exercised on the highway. In a few cases, highway or building construction forced the temporary or occasionally permanent transfer of a station to some nearby, but similar, spot. The actual area of the station was small, less than half an acre, but the extent of contiguous area in good vole habitat varied greatly. At each station, a judgment was recorded as to the quality of the habitat at each visit.

The level of the local population was inferred from the relative abundance of signs of activity. The appraisal system was based on the fact that *Microtus* leave characteristic signs of recent activity in the form of piles of grass cuttings, trails cut through the grass, piles of droppings along the trails, occasional nests and, rarely, live animals or a litter of young animals in a nest. As used by Hayne, the method did not discriminate the somewhat similar signs of activity of other microtines, notably the bog lemming (*Synaptomys cooperi*). The quantitative interpretation of these records assumes that the more signs there are, the more animals are present.

A numerical grade was assigned at the station after a careful examination for signs at a number of small areas of sod about nine inches in diameter. These locations were chosen as the points where, in the investigator's experience, one would be most likely to find signs; such as beneath long over hanging grass, in wheel ruts, beneath any considerable litter on the ground, where grass was heaviest, or in stream-side vegetation. The ground cover was lifted or pulled apart, using a 3-foot steel rod with two counters taped to the handle and terminating in a finger-like offset hook. In 1949 and thereafter, exactly 25 points were examined; previously the rule was to examine 25 or more. If signs were found at one point, then the next was chosen several feet away. Signs were recorded as present principally on the basis of finding fresh cuttings or droppings. Special emphasis was given the freshness of the material, and if it was appreciably dried or weathered it was not accepted as evidence of recent activity.

The system of assigning grades evolved through several stages, beginning with a recording of simple presence or absence of signs. In 1947, an 11-point scale was adopted, ranging from 0 to 10 (details given below). After a few years' use, it became clear that grades were being assigned almost solely according to frequency of signs, and a shift was made to the use of frequency records, with both types of records being made at each station for the years 1954 through 1957. For this study, the frequencies recorded in 1958 and 1959 were transformed by use of these double records to grades comparable to those used earlier.

Characteristics of the grades scale were defined by a series of descriptive phrases carried in the field and referred to constantly as long as the grading system was used. The odd explicitly, numbered grades were never defined, being intermediate to those of even number. For the work presented here, grade 1 was scored as zero since use of this grade only implied doubt that signs had been found and, therefore, grade 1 cannot be retrieved from the frequency records. At the upper end of the scale, grade 10 referred to some vaguely-defined maximum condition equivalent to a mouse plague, beyond anything seen in this study; in fact, grade 9 was used only five times. A description of the grades follows, along with the frequency ranges used to transform frequency to grade for the records of 1958 and 1959.

Criteria for judging and recording abundance of signs of *Microtus* activity:

0. No trace of activity or any signs which can possibly be interpreted as activity or presence (0/25).
1. Scattered signs doubtful; could indicate *Microtus* activity, but not with certainty.
2. At least one characteristic indication of activity, or a few scattered sure signs, but where such definite signs are still rare (1-2/25).

3. (3-4/25).
4. Scattered sure signs, no longer rare (5-7/25).
5. (8-10/25).
6. Signs of activity moderately abundant and moderately heavy but not present at every spot examined (11-15/25).
7. (16-19/25).
8. Numerous signs, present at almost every point examined; sign quite heavy (20-23/25).
9. (24-25/25).
10. Maximum possible condition of signs of activity, "plague conditions" (25/25).

The differences in population levels represented by the successive intervals in this system of grades are strongly suspected to vary in different parts of the scale. It is our opinion that the difference between grades 8 and 9 probably reflects a greater population differential than the difference between grades 0 and 6.

Thompson's work in Wisconsin started in 1959 following investigations with lemmings in the Alaskan Arctic (Thompson 1955). The first few weeks following snow retreat were selected as the best time to measure forage utilization and dropping accumulation. Signs from both of these sources gradually accumulate throughout the winter months and provide an index which is a summation of vole activity over the previous months. Observations were limited to undisturbed upland grassland to avoid confusion with the activities of other forms such as the cottontail (*Sylvilagus floridanus*) and the bog lemming.

Seventeen Wisconsin stations were set up in 1960. These were arranged in two transects running north-south and east-west from Ripon, with an average interval between stations of about 20 miles. Results are reported here from 13 of these stations for which records are available for the entire span of 5 years (1960-64). In the vicinity of each station, the best sample of grassland cover was selected, using these criteria:

1. Undisturbed adventive grass cover with full set of flowering stalks.
2. No shrubs, rock piles, trees, trash, or other cover to offer rabbit den sites within 50 yards.
3. Large enough to harbor a local population (1 acre) or continuous with other grassland cover such as railroad right-of-way or roadside.

A suitable site for a station was selected, and 10 plots were paced off in a transect crossing the greatest dimension of the habitat. A each sampling point, the following measurements were taken on a 1/100 meter^2 plot: (a) percentage of stems cut, (b) number of droppings, and, starting in 1962, (c) cover value. An index of cover was obtained by measuring incident light at the soil surface with a Weston photometer. This paper reports only on results from percentages of stems cut.

RESULTS

The general question of interest here — whether there is a relationship between the population levels observed at sample stations and at adjoining stations—has been tested by examining the correlation between year to year values at adjacent stations. Correlation is used here as a measure of the relationship in the sense that the square of the correlation coefficient estimates the proportion of the variability in one series, which is associated with fluctuation in the other series when one postulates a linear regression. The relationship is examined here in two kinds of data summaries.

Neighboring Station Comparison

First, in Hayne's data, the 197 stations were associated as 94 pairs on the basis of geographic closeness of the pair members, ignoring information from the remaining 9 stations. The mean distance between pair members were 7.7 miles. For each of these pairs, a calculation was made of the correlation of the grades of mouse sign, from year to year, for the spring and the fall records separately. Then all records were combined on the basis of deviations from the respective mean values and a correlation coefficient of 0.28 calculated from the pooled data, based upon 829 degrees of freedom. While this coefficient indicates an association greater than that expected by chance with this large a set of observations, it is surely of doubtful practical or scientific value except as evidence of some minimum detectable relationship. On the other hand, any relationship may well be obscured both by the high variability of the populations examined, and by the large measurement error. Thompson's data did not demonstrate a significant correlation in this kind of examination ($r = 0.25$, 18 degrees of freedom).

Route-to-Route Comparison

In the second approach, in examining the relationship between these neighboring pairs, one member of each pair was assigned at random to each of two different series, and for each series, at each appropriate time, a central value was calculated (medians in Hayne's data, means in Thompson's). The two series of central values were next correlated within each set of data. With Hayne's data, 5 such sets of data have been formed, each referring to the designated part of Michigan. Spring and fall data were pooled in the manner previously described. The regions of Michigan and results are as follows:

Region	Number of	Degrees of	r
Upper Michigan	21	7	0.74
Northern Lower Michigan	17	13	0.66
Central	15	20	0.85
Southwest	16	20	0.78
Southeast and East	25	21	0.80

In a preliminary examination, a set consisting of 36 pairs in the central and southwestern part of Lower Michigan yielded a correlation coefficient of r = 0.93 (20 degrees of freedom). All of these correlations are significant at beyond the one percent level, except for that for Upper Michigan which is significant at the five percent level. For Thompson's data, which relate only to spring observations in Wisconsin, a similar treatment reveals r = 0.91 (3 degrees of freedom) a value significant at the five percent level.

DISCUSSION

The results indicate that there is a demonstrable degree of relationship in the signs of activity as we have recorded them on areas within 20 miles of one another. We assume this to mean that records like these made on a series of study stations can be used to estimate the average population level of voles on similar areas within this distance as a fairly reliable estimate of conditions for a region. From the economic point of view, it would seem that such information might be useful to an agency involved in a widespread program of planting trees or shrubs, or perhaps to a corporation operating a large number of orchards.

Regarding the possibility of setting up a system for warning individual orchardists in a fruit-growing region, one may question the usefulness of any such estimate. For the individual orchardist such an estimate would not relate precisely to his particular orchard, being only in terms of the average condition. Although it is not clear that our findings agree precisely on this point, at least in Hayne's data there appears to be a high variability from station to station in any one year, and it seems that damage could occur in the individual orchard even though the average condition in an area might indicate relatively low hazard. Because of this high variability, individual orchardists may still find the risk of damage to be too high to ignore in a year of relatively low hazard. It was Hayne's experience in attempting forecasting based upon such information that the extension specialist in horticulture was above all unable to use the information. Possibly this was because, in his position of advising orchardists on operations, he might well be held accountable for the scattered damage which did occur in a year of low hazard if he offered advice which discouraged the control of mice.

In summary, we find that our methods of field appraisal seem to allow meaningful estimation of the average population condition throughout a region, even though the practical application of this information to a particular economic enterprise can be made only with due regard to the variability of local populations and the potential damage from the occasional high population during a year of generally low numbers.

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DISCUSSION

VICE CHAIRMAN SADLER: Dr. Thompson, did you find any population changes tha occurred in patterns following food and cover availability, or was the abundance of food and cover not correlated with annual densities?

DR. THOMPSON: That is a very interesting relationship; indeed, it is one of the questions which led me to do this study.

From observations of Midwest vole populations, I surmised that these fluctuations were very different from the brown lemming in arctic Alaska. My hypothesis is that food and cover changes are not strongly correlated with Midwest vole fluctuations. Even in areas of heavy utilization, total utilization over the primary sampling unit would not exceed 75 percent. Furthermore, the rapid recovery of Midwest grasses plays a part in this; when the snow goes, they grow many millimeters each day, partly in response to vole urea. Therefore, in the present analysis, there is not much evidence that food is an important factor in Midwest vole fluctuations.

I do have some cover measurements which I am taking with a light meter and am getting a positive relationship with vole densities, but, at this point, I am not ready to make any statement as to its importance.

DR. FRED WAGNER (Logan, Utah): Are you suggesting that causal effects operate at random in Midwest vole populations?

DR. THOMPSON: Yes, with the exception of synchrony, the population characteristics described by my data are not unlike one of LaMont Cole's mathematical models.

DR. WAGNER: Might not weather operate at random?

DR. THOMPSON: It probably does, Fred. What we may have here, is a super factor operating occasionally. There may have been a climatic disaster back in the thirties that could have set all of these stations back to zero. They are now pulsating independently and separately and may be getting out of phase again; however, they did have this common event. This is the most reasonable explanation that I can think of which would reconcile the paradox suggested by these data.

THE RELATION OF ANIMAL BEHAVIOR TO WILDLIFE MANAGEMENT

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The study of animal behavior, or ethology, has increased markedly in the past decade. The ethologist asks these questions of the behavior he observes: "What is its cause, its function, and its origin?" The ethologist seeks ultimate explanations for behavior. Hence he is curious about the neural and other physiological mechanisms that mediate behavior. It is this absorption of the ethologist in the underlying mechanisms of behavior, rather than its application, that raises skepticism in many wildlife managers about the value of ethology to practical wildlife management.

It is our purpose here to suggest ways in which knowledge of animal behavior can help solve management problems. We shall discuss its application to three areas: population studies, the inventory of wildlife and its harvest, and the management of the animal and its habitat.

Many wildlife ecologists are interested in the natural regulation of animal numbers. The factors that determine the density and fluctuations of a population are complex. We contend that such studies require a team of at least three specialists: first, the population ecologist to prepare the balance sheet of births, deaths, and movements, and to relate these to density and fluctuations; second, the physiologist to investigate the role of nutrition and changes in the reproductive and hormonal systems in relation to reproduction and mortality; and finally, the behaviorist to determine how social interactions among the population in turn affect the animal's ability to reproduce and survive, either directly or through changes in its physiology.

Most of the early studies on the effects of behavior in regulating density were on confined populations at much higher densities than would normally occur in the wild. Recent studies of European rabbits (*Oryctolagus cuniculus*) in enclosures of several acres have somewhat overcome these limitations (Mykytowycz, 1961; Myers and Poole, 1962). J. J. Christian (1963) has recently written an exhaustive review on the relation of behavior to endocrines and populations. In speaking of the fundamental factor regulating population growth he states (p. 263) "the only known common element to all populations is social interaction, or intraspecific competition." Increase in density results in increased social interaction, followed by effects on hormone production, especially those of the pituitary and adrenal glands. These endocrine changes in turn affect natality and mortality and eventually population density. Subordinate animals are the first to feel the effects of increasing social interaction, but no individuals are immune from these effects.

Early studies on territorial behavior in birds stressed overt aggression as means for limiting density. However, social interaction may be much more subtle and not readily apparent to the observer. David Jenkins (1956) has shown this in a study of a natural population of partridge (*Perdix perdix*). He observed that there was little actual fighting, but the mere sight of other birds affected their behavior. Where visibility was high there was much social interaction and also more time spent on the alert rather than feeding or courting. In years and places where visibility, and hence social interaction, was high during the spring, subsequent viability of eggs and survival of the chicks was low. Even those chicks hatched from wild eggs in an incubator and fed standard game bird feed survived less well if the eggs came from hens subject to high interaction. Hence, the frequent interactions that affected the hen's behavior also affected the quality or her eggs. Jenkins postulated that the high rates of social interaction produced stress in the birds with consequent effects on their reproductive system. A somewhat similar phenomenon occurs in pheasants, where the rate of nest desertion rises with the density of breeding birds (Stokes, 1954, p. 36). The above studies refer to competition between individuals of the same species. However, there is some evidence that competition between individuals of different species also occurs.

Recent studies show that when one traps small mammals in an area, the daily catch of some species may steadily decline. This presumably reflects the removal of a significant part of the population in the trapped area. At the same time the numbers of another species being trapped in the same area may remain low for the first week of trapping, then rise steadily for one or more weeks (studies by Barbehenn, Patric, Webb, and others reported in Calhoun, 1963, pp. 26-34). In his intriguing analysis of this phenomenon, Calhoun postulates that some species dominate others, hence restrict their movements. Only when the dominant species has been reduced in numbers do individuals of the subordinate species increase their activity and home range, thereby increasing the probability of their encountering the grid of snap traps. This phenomenon occurs even when the dominant species is the seed-eating white-footed mouse (*Peromyscus*) and the subordinate is the carnivorous short-tailed shrew (*Blarina*). If Calhoun's explanation of these trapping phenomena is correct, perhaps similar competition occurs between larger species. Competition between certain sympatric gallinaceous birds was postulated twenty years ago (McAtee, 1945, pp. 59-60, 230), but since then largely discredited or ignored. Calhoun's speculation suggests we should re-examine the possibility of one species dominating another by behavioral means.

All of the above examples fall far short of providing an explanation of the natural regulation of animal numbers. The reason is obvious. Only when we study simultaneously populations, physiology, and behavior will we have much chance of success.

Not many wildlife managers are directly involved in research in population ecology. Rather, most of them spend considerable time measuring certain attributes of wildlife populations. These include seasonal and yearly changes in density, sex and age composition, and reproductive rates as indicated by young: adult ratios and pregnancy rates. More and more these surveys must be suitable for statewide coverage. Hence the wildlife manager finds himself in large part behind the steering wheel, or better yet, in an airplane.

This activity is quite in contrast to what an aspiring wildlife biologist imagines it to be. A wildlife biologist goes into our field because of his boyhood interest in animals. He visualizes a biologist spending his time observing animals in the wild. By the time he leaves college he is reconciled to the fact that he will be measuring the attributes of a population more than observing individual animals. Somewhere along the line he gets the impression that statistical analysis produces infallible conclusions. He spends hours behind his desk designing sampling procedures, but gives only lip service to the question of the validity of his assumptions. Some admit the bias in sampling but shrug it off on the usually untested assumption that its magnitude is constant from year to year.

One such sampling technique is the roadside count. Many states conduct roadside counts of pheasants in fall to determine the sex ratio. Invariably such counts indicate more cocks than hens, usually about 120 cocks/100 hens. Yet this ratio is unlikely in view of the great excess of hens over cocks in the spring and the 1:1 sex ratio of juveniles. We find that a difference of just an hour in time of making counts makes a great difference in the observed sex ratio (unpublished data). The only real test of the validity of such counts is to study a population of known sex ratio and find out the time of day and year and method of observation that will produce the most accurate count.

We have been able to make such comparisons this past year with a population of Uinta ground squirrels (*Citellus armatus*). We were able to trap and mark all of the 180 animals on an 8-acre area

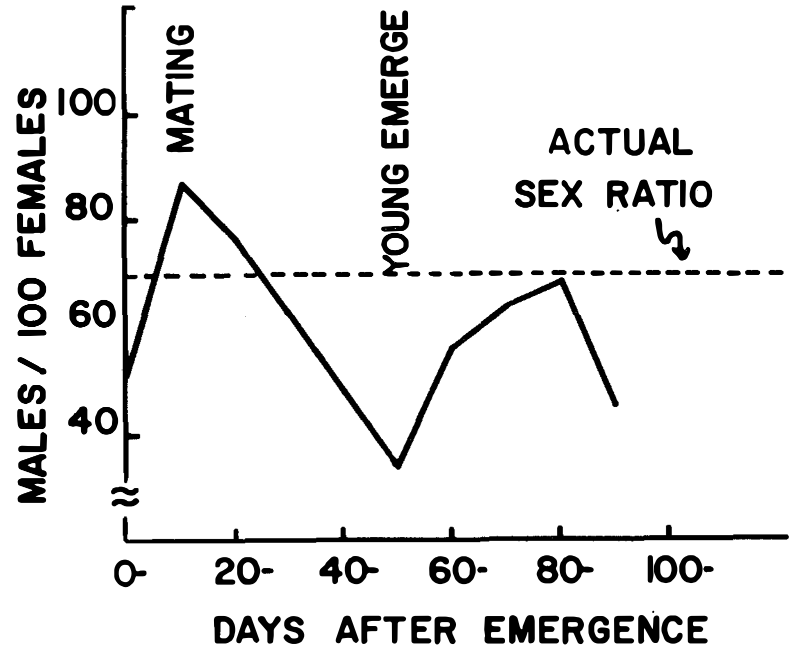

Figure 1. Changes in observed sex ratio of Uinta ground squirrels throughout the season in relation to the actual sex ratio.

shortly after they emerged from hibernation. We continued trapping throughout the spring and summer. This allowed us to compare the sex ratio of the trapped sample in any given time interval with the actual sex ratio (Figure 1). Males were relatively more trappable than females only in the brief period soon after emergence from hibernation when they were in breeding condition and most active. Following breeding the females established territories and became intolerant. We attribute the steady drop in relative captures of males to the increasing intolerance of females right up to the point of emergence of their young. Following this, males again started to move more freely among the females' territories and they were also captured more often. Hence, had we been relying on a trapped sample on which to base the sex ratio, only during the brief period after the peak of breeding or again just prior to hibernation, would we have gotten anywhere near the correct sex ratio. The sex ratio would have been even more incorrect had we taken our sample by shooting or sight counts. An alternative way to arrive at the true sex ratio by trapping would have been to alter our trapping methods.

We observed that females bred largely in open, grassy areas; the males after breeding withdrew largely to brush areas with abundant herbaceous cover. Hence, had we trapped more intensively in the brushy areas we would certainly have come up with sex ratios closer to actuality.

We frequently rely on trapping or shooting to determine other attributes of a population, such as weights, pregnancy rates, litter size and survival rates. Again, we assume we sample a representative portion of the population. However, we know that the behavior of an animal depends to great extent on its position in a social hierarchy. Thus, subordinates tend to move less, over shorter periods of time, and over more restricted areas. Such animals are likely also to be lighter, have shorter breeding season, smaller litters, and lower survival (Mykytowycz, 1961). But mobility also depends upon reproductive condition. Breeding males and females in heat tend to be more active. Hence, it seems highly likely that attributes of a population that rely on sampling by the above methods will almost invariably fail to meet the statistician's standard of random sampling.

Five years ago, David E. Davis (1960, 5:27) wrote "The failure of wildlife investigators to check population estimates against known numbers is a deplorable situation." The situation is unchanged today. Not only must wildlife investigators check their estimates against known numbers, they must then seek the reasons why observed numbers depart from actual. The only way to do this is to observe the behavior of the animals themselves. Let us sever the biologist from the throb of the gas pedal and let him devote more time once more to really studying the animal he wants to manage.

So far we have been speaking of rather elementary approaches to behavior, ones which require no specialized training to study and record. We would now like to present a few, more sophisticated, behavioral approaches to wildlife problems. We are letting our imaginations run a little wild, but such studies might lead to solutions of presently unsolved management problems.

First, let us look at a phenomenon known as "imprinting." Canada Geese (*Branta canadensis*), along with many other precocial birds, do not have an inborn recognition of their parents or species. Instead, within a few days after hatching, they learn the characteristics of the parents. They do this by following the first moving object they see. In the wild this is normally the parent. But when hatched artificially and away from others of their own species, young birds may follow anything ranging in size from a shoebox to a man (Hinde, Thorpe, and Vince, 1956), if this is the first object they observe moving. Later, they learn other characteristics of the parent. This kind of learning, which is confined to a critical, brief period in the animal's life, is known as imprinting. Recently, imprinting has come to include other things than learning the characteristics of the parent and species. Thorpe (1961) speculates that many species have no inborn recognition of their typical habitat. Instead they learn these characteristics during some critical period in early life, probably somewhat later than the time of imprinting to the parents. Wecker (1964) states that the white-footed mouse (*Peromyscus maniculatus*) relies on both innate and learned stimuli in selection of habitat. If some animals do learn the characteristics of their habitat during early life and seek out similar habitats in which to breed, this may have management implications. We know that Canada Geese are very slow in dispersing from well-established breeding grounds. This has been attributed to the strong family ties and the northward migration of yearlings and even two-year-olds with their parents. Could this, however, be such a strong imprinting of goslings to the habitat of their birthplace that stimuli coming from other habitats are insufficient to release settling down and breeding elsewhere? When we transplant geese from established flocks, at what age should we do this before the goslings have imprinted to their habitat? If imprinting to specific habitat does occur, to what specific stimuli from the habitat does the species imprint? Among song birds the specific kind of plant is relatively unimportant. Instead, the presence or absence of a particular species of bird in an area depends on the vertical distribution of foliage (MacArthur and MacArthur, 1961). Hence, the habitat that an animal recognizes may be much less complex than we now assume.

Another problem we face is the preservation of endangered species. This may involve taking such drastic steps as rearing the animal in captivity with hopes of then re-establishing it in the wild. The Hawaiian Goose (*Branta sandwicensis*) has been brought from the verge of extinction by such methods. Geese are remarkably easy to breed in capitivity. But what about the Whooping Crane (*Grus americana*) and California Condor (*Gymnogyps californianus*)? What environmental factors are necessary for them to reproduce?

We know that the stimuli necessary to release breeding in an animal are both internal and external. The internal stimulation in many birds is a combination of adequate nutrition and hormonal level. The external factors consist of many heterogeneous stimuli. They include photoperiod, temperature, kind and stage of vegetation, nest substrate, food supply, as well as stimulation from others of their kind. Few of these stimuli are absolutely essential. Thus, if the internal stimulation is strong, the level of external stimulation may be correspondingly weak. Nice (1937, p. 65) observed that in early spring Song Sparrows (*Melospiza melodea*) sing only on unusually warm days, *i.e.* strong external stimulation. Later in the year, when internal stimulation as measured by testosterone levels is higher, Song Sparrows sing despite cold weather. The challenge to aviculturists is to find the combination of stimuli that will bring a bird into breeding condition. With some species success lies in improved nutrition. With others, it is provision of some specific kind of nest material, cover, or exposure to mate. Aviculturists have been eminently successful in discovering the combination of stimuli necessary to release breeding. Wildlife biologists have by and large failed to profit from their experience.

The presence of some key element in the environment to release breeding is not confined to birds. Fabricius and Gustavson (1955) studied breeding behavior of grayling in a large flume with glass front and simulated natural spawning conditions. Although the male would defend a territory and prepare a redd, the females failed to spawn. Instead the males attacked them. However, when stone grottoes were placed along the side of the tank, spawning occurred within a very few hours. The females needed a retreat where they could escape the attacks of the territorial males. When the female could make successive advances and retreats, the male became accustomed to her, soon accepted her, and spawning occurred. Only by chance would a spawning stream have the perfect balance between proper gravel for spawning and adequate nearby shelter for females. Will our streams of the future incorporate the findings on this study of captive fish?

The stocking of fish, especially trout, is an effective way to increase sport fishing. More trout are stocked every year. We know what size trout are most economical to stock under present rearing methods, but we know very little about why stocked fish die. Starvation, predation, and physiological stress are three strong possibilities. Hatchery fish receive a highly artificial diet until released. Could fish imprint to this artificial food and have little inborn recognition of their natural foods? If so, they may starve before they learn to shift to new foods. Should we not observe how fish actually shift from one type of food to another to see how quickly this occurs and whether some fish may never make the shift? Emlen (personal communication) has observed that some domestic chicks do indeed starve before they learn to eat new foods. Young fish might starve, not because food was lacking, but because they did not recognize it as food.

One characteristic of stocked animals is reduced wariness. This is partially because they have lived in an impoverished habitat—one low in diversity of stimuli. Increasing the complexity of the hatching tank and rearing ponds might make these fish more responsive to sources of danger in the wild. Most animals avoid predators, not through inborn recognition, but because they tend to avoid strange objects of all kinds. It is possible by means of shock, or other aversive stimulus, to condition an animal to avoid almost anything. It should not be difficult to condition whole schools of fish to avoid objects having superficial resemblance to a larger fish. If this were done prior to release into a stream, there might be quicker response to predators and allow higher survival of young fish. Some fishery biologists in Japan are presently investigating this possibility.

Physiological stress must almost certainly occur when fish are taken from a hatchery and released into strange surroundings. Miller (1958) found that hatchery-reared trout of catchable size survived very poorly when placed in streams in competition with resident trout. The high lactic acid levels among the survivors led him to believe that stocked fish spent most of their time actively moving about. He suspected that intolerance from the resident fish largely prevented them from finding either a resting place or food. Hence they succumbed from starvation or acidosis.

The challenge to the hatchery man should be how to rear fish to make them best suited to the sudden change of stocking. Up to now we have had no measure of the physical condition of fish. Psychologists have now provided the technique. It is possible to condition fish in tanks to avoid a light source, using electric shock as the conditioner. Various behavior patterns occur during and after such conditioning. These include speed of reaction, total distance moved away from light source, degree of schooling, speed at which conditioning occurs, and time for extinction of the response to light once the shock has been stopped. Instrumentation for such tests has been designed by a consulting firm (Engineering-Science, Inc., 1964) wishing to measure the effects of sublethal toxicants on fish. This device has detected quantitative differences in behavior between fish in pure and toxic waters. Such tests have immediate application in law suits involving pollution.

Currently D. R. Franklin at Utah State University (personal communication) is using a similar device to measure resistance of fish to stress. First, the normal response to an aversive stimulus will be determined. Fish will then be stressed by placing them in water flowing at different velocities and for different lengths of time. The degree of stress imposed will alter their ability to respond to the same aversive stimulus. If this method proves valid, one could determine the effect of various conditions of rearing, including diet, crowding, and water quality. It would then be possible to approach the problem of how to rear the fish best adapted for stocking.

The same methods should apply to game birds. Any reduction in reaction time is likely to reduce the animal's chances of avoiding predation. In addition, reduction in response to stimuli might prove to be a good predictor of an animal's ability to resist environmental stresses.

An unsolved problem in management of migratory fish is how to get them past dams. Fish ladders are moderately effective in getting fish upstream. But downstream passage has been vastly more difficult. Fish of the proper age may start downstream, but on reaching the still water of an impoundment may wander aimlessly and fail to reach the downstream end of the lake and the passageway. I suspect the solution will lie in finding some especially strong guiding stimulus, stronger than anything normally occurring in the wild, a so-called "supernormal stimulus." This phenomenon was first described by Tinbergen (1951, p. 44). Tinbergen was studying what properties of eggs released incubation in birds. He tested this by giving the bird a choice of two nests with different types of artificial eggs in one and normal eggs in the other. He discovered that many aspects of the egg were important: size, shape, color, pattern and number of eggs. No one character was essential, but the addition of each additional character released stronger incubation behavior. Finally, when he combined the optimum size, shape, color, pattern, and number of eggs, the bird would often choose this combination over her normal clutch of eggs, even if it meant sitting on oversized eggs. We believe we might devise similar supernormal stimuli to attract fish to the downstream passageway. Manufacturers of fishing tackle now employ ethologists to design fishing lures that incorporate supernormal stimuli. Perhaps commercial fishermen could use a similar approach to lure fish into seines or at least to concentrate them behind a trawler.

In this paper we have shown how the study of behavior is important to wildlife management. Too few people in our profession are aware of its importance. We suggest these ways to overcome this lack. We should initiate courses in animal behavior in our wildlife training, and also incorporate behavior in our current courses in ecology and management. We should stimulate wildlife students to undertake behavioral research and should educate fish and game administrators to the need for it. Wildlife ecologists should read in the field of animal behavior with the idea of applying behavior concepts to their management problems. It is encouraging to see more and more wildlife ecologists attending the animal behavior sessions of the AIBS and the AAAS meetings. Those in college teaching could get a solid training in ethology by attending a summer institute in animal behavior.

Today, a wildlife ecologist routinely consults a statistician to help design sampling procedures. He should, also, routinely go to the behaviorist for help in solving problems. Such increased contact should make the behaviorist more aware of the biologist's problems and lead to greater team effort in their solution. We predict that in twenty-five years animal behavior will be as much a part of wildlife management as population ecology is today.

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REGULATION OF PHEASANT DENSITY THROUGH NEST ABANDONMENT IN SOUTH-CENTRAL NEBRASKA[1]

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In a five-year study of the ring-necked pheasant (*Phasianus colchicus*) in south-central Nebraska, Linder, Lyon and Agee (1960) proposed that "the quality of nesting environment determines the number of nests which will be successful in a given year; this regulates total production which in turn determines the following year's breeding population." These conclusions were based upon the following findings:

1. A close correlation existed between the number of chicks produced and the number of hens the following spring. Because of this relationship it was concluded that mortality through fall, winter and early spring was relatively constant from year to year and adjustment to a higher or lower population level occurred during the nesting season.
2. The study area was in a region of intensive agriculture and nesting occurred in a relatively restricted acreage. Nearly 90 percent of the chicks were produced in two cover types: (1) roadside, in which early production took place and (2) wheat, where most late nesting occurred.
3. A considerable amount of renesting occurred indicating previous failures. As the total number of hens in the spring population increased, the average number of nests established per hen also increased indicating a higher rate of failure. It was suggested that in years of higher populations there was a greater incidence of voluntary abandonments.
4. The number of chicks produced was not a function of the number of hens currently in the breeding population; rather, the nesting environment appeared to govern the number of nests which was successful each year.

Since environmental factors apparently inhibited further hatching after a particular number of chicks was produced, a hypothesis was proposed (Linder and Agee, 1963) which seemed to explain the mechanism of population adjustment as it occurred in the population under study. The hypothesis was expressed in three parts, as follows:

[1] A contribution of Nebraska's Pittman-Robertson Project W-28-R, "Life History and Ecology of the Ring-necked Pheasant." Presented at thirtieth North American Wildlife and Natural Resources Conference, March 8-10, 1965. Washington, D. C.

A. The number of young produced was controlled by nest abandonment during incubation.

B. The stimulus for abandonment was furnished by association with chicks hatched by other hens. These associations occurred most readily when nesting cover was sparse and afforded minimum concealment.

C. This tended to establish an upper limit upon the number of broods which could be hatched and brooded in a particular unit of cover, regardless of the number of breeding hens present.

Operation of the hypothesis would depend upon the existence of a behavioral pattern whereby a hen would abandon her nest upon stimulus from chicks hatched by another hen. It would further require that areas occupied by nesting hens and by broods overlap sufficiently to provide opportunity for contacts and that family ties be sufficiently flexible to permit associations between unrelated hens and chicks. It was along these lines that work was performed to test this hypothesis.

LITERATURE REVIEW

Since relatively little has been published on the physiological and behavioral aspects of nesting wild galliforms, it was necessary to rely largely on literature dealing with birds of other orders.

There is agreement among endocrinologists that the biological changes related to the reproduction cycle are brought about by hormones (Eisner, 1960) and several authors have shown that the hormones are triggered by environmental factors. Hence the reproduction cycle in birds depends on internal changes set in motion by external factors operating through the endocrine system (Hinde and Warren, 1959).

Work done on several species lends support to the suggestion that young chicks normally prompt the hen's advancement from care of the eggs to care of the young.

Tinbergen (1953) discussing parental behavior in birds, stated that the external stimuli are provided by the young and that, in some birds, there are indications that the stimulus is given by chicks while still in the egg. Most probably the parents react to the calls which can be heard before hatching.

That young can provide stimulus has also been shown in other species, including jewel fish, (*Hemichromis bimaculatus*) (Noble, Kumpf and Billing, 1938), other cichlid fishes (Greenberg, 1963), and bobwhites (*Colinus virginianus*) (Anon, 1922). In the latter species, adoption of incubator-hatched young by foster parents was readily brought about by confining them together. Responses were also noted by Vilks (1958)working with passerine birds. He commented that if two different stimuli were acting on the nesting bird simultaneously during the nesting period, the bird responded to the stimulus of the phase which had not yet started. He believed the patterns were characteristic for the whole order and perhaps for all birds.

Emlen (1941), working with the tricolor redwing (*Agelaius tricolor*), concluded that following the initiation of incubation, behavior was largely controlled by external situations associated with the nest. By introducing strange young into nests he was able to cause incubating females to advance prematurely out of the incubation phase. It is reasonable to expect that the same phenomenon might occur in pheasants, and cause nest abandonment.

From brood observations reported in literature it appears that familial ties in the pheasant are not firm. Mixing of broods is evidently frequent in the wild and many chicks are observed without hens. This indicates that unattended chicks as well as those accompanied by hens are available to provide external stimuli. Hiatt and Fisher (1947) reported that large numbers of broods were not attended by hens and that such broods increased during the summer from 14 percent in June to 35 percent in October. Wagner (1957) reported that in Wisconsin a similar progressive increase in broods without hens was observed. Stokes (1954) observed that in a population with a density of over 30 birds per acre, chicks frequently wandered about with no adult hen in sight. He also reported that in high density populations, two or more broods frequently intermingled. Kozicky (1951) believed unsuccessful hens were associated with pheasant broods in Iowa. Hiatt and Fisher (*op. cit.*) also found broods were sometimes attended by more than one hen.

While literature generally supports the hypothesis, specific evidence is scant. For this reason data gathered on established study areas in southern Nebraska since 1954 were scanned and experiments with external stimuli were initiated to check further the credibility of the hypothesis.

DESCRIPTION OF AREAS

Studies reported here were conducted on three areas in south-central Nebraska. Two of the areas, near Harvard and Clay Center in Clay County, were used to evaluate use of cover for nesting and rearing. The third area, the Sacramento-Wilcox Game Management Area (referred herein as the Sacramento Area) in Phelps County, was used for evaluation of use of cover for rearing and experiments with external stimuli.

Clay County is a region of gently undulating uplands slightly modified by stream erosion. Soil types in this area are largely silt loams with soil pH values ranging from 5.4 to 8.3 (Roberts and Gemmel, 1927).

The climate of Clay County is characterized by long, moderately hot summers and cold, dry winters. Mean monthly temperatures range from 25 degrees Fahrenheit in January to 79 degrees in July. Mean annual precipitation is 22.5 inches, of which 43 percent falls during May, June and July (Weather Bureau, U.S. Dept. of Commerce, 1955-62). The average growing season is 155 days (Roberts and Gemmel, *op. cit.*).

Using 1958 as a typical year, nearly all of the land of the Clay County study areas was intensively cultivated or grazed. Of the total acreage, row crops (corn and grain sorghum) occupied about 41 percent; winter wheat, 22 percent; pasture, 8 percent; and alfalfa, 4 percent. The remainder was winter barley, oats, sweet clover and native hay.

Roadsides, fencerows, and odd areas occupied about three percent of the total acreage. Odd areas were comprised largely of farmsteads and railroad right-of-ways which had been abandoned and had reverted to mixed grasses and forbs.

Deep-well irrigation was practiced on the study areas. Irrigated crops were corn, grain sorghum, alfalfa, and wheat. Corn and sorghum comprised more than 90 percent of the total acres irrigated (Linder *et al.*, 1960).

Studies on the Clay County areas were carried out to estimate use of cover for nesting under undisturbed conditions. For the study of induced nest abandonment, the state-owned Sacramento Area was selected because of the high density of nesting pheasants. The latter is a tract of about 2,300 acres located in south-central Nebraska with soils of loessial origin. It consists of a broad, shallow basin (lagoon) surrounded by an uncultivated perimeter which extends to cultivated uplands irrigated by deep-wells. During the study water areas of the lagoon varied with amount of precipitation. Portions of the perimeter which were subjected to intermittent flooding were vegetated primarily by smartweed (*Polygonum* spp.), sunflower (*Helianthus* spp.), and sedges (*Carex* spp.), An area consisting principally of western wheatgrass (*Agropyron smithii*) and smooth brome (*Bromus inermus*) lies between the high water line of the lagoon and the uplands cultivated to corn, grain sorghum and wheat.

PROCEDURES AND RESULTS

Distribution of nests:

Various habitat types were studied on seven sections of the Harvard

Area to determine if hens nested in cover used by chicks (Linder, *et al.*, 1960). Each type was sampled to determine the extent of nesting and the rate of nest success (Stokes, 1954). Production from each cover type was calculated.

Six vegetation types which comprised available nesting cover were: wheat, pasture, alfalfa, roadsides, odd areas and fencerows. Approximately 87 percent of the chicks were produced in nests located in wheat and roadsides. While 25 percent of the nests occurred in alfalfa, mowing destroyed nearly all of them. Pasture, fencerows and odd areas held 12 percent of the nests and only 6 percent of the chicks were produced in these types because of the restricted acreage and/or poor quality cover that existed there.

Roadsides were used extensively for early nesting cover. Only four percent of the acreage of nesting cover was in roadsides, but 21 percent of the nests occurred in that type and 29 percent of the chicks were produced there. Predation and abandonment were observed as the main factors in nest failure. Mammals destroyed 39 percent of the nests; abandonment accounted for 19 percent. The high rate of destruction by mammals probably reflected the use of this cover type for travel lanes and hunting areas. Nest abandonment occurred early in the season and may have represented a normal occurrence (Buss, *et al.*, 1951). It should be pointed out that a study such as this cannot identify accurately all cases of abandonment. As mentioned by Stokes (1954) and Kimball, *et al.* (1956), nests destroyed by predators and farming operations include those previously abandoned by the hen.

There was an increase in chick production in roadsides with increase in density of vegetation canopy, but, the number of nests established did not increase. This suggested that canopy density had a greater influence upon success of nests than it did upon their establishment (Linder, 1964). While the greater concealment afforded by the denser canopy may have reduced the efficiency of predators, it also diminished the chance contacts between incubating hens and young. A relationship between density of roadside cover and production of chicks in widely scattered areas of Nebraska was also reported by Wiegers and Agee (1962).

Wheat was an important cover type for late nesting. More than 41 percent of all nests were in wheat and about 58 percent of all chicks produced were hatched there. Although there was a large acreage of wheat (65 percent of the nesting cover), nest densities were low. Predation and farming operations were the main causes of nest destruction. Abandonment occurred in 16 percent of all nests established in that type.

There was a comparable increase or decrease in numbers of nests established in wheat and roadside each year. However, when chick production was high in roadside, production was low in wheat and vice versa.

Distribution of broods:

Studies on cover usage by chicks were conducted. Vegetative types important for nesting were sampled at different times of the day by flushing and counting chicks. Cover used for roosting was sampled by walking each land parcel in the morning before the birds left the roosting areas. Additional information on roosting was obtained by searching transects at night with the use of flood lights (Smith, 1954). Counts showed that wheat and roadside were used extensively by young birds throughout the day. For roosting, wheat and lagoon areas were the most important with lagoon land assuming greater importance in dry years.

Contacts between unrelated hens and chicks would occur most frequently if the brood and the maternal hen did not display strong family bonds. Records were kept of broods sighted on the Clay County Areas from 1955 through 1962. Counts conformed to the methods described by Bennett and Hendrickson (1938). For each brood observed, data on the number of young present, their estimated ages and the number of hens were recorded. During the study 5,947 young birds were observed. Of these, 23 percent were not with hens. It was also noted that 40 percent of 873 hens were not accompanied by young. In other studies, large numbers of hens without chicks were observed (MacMullan, 1960; Mohler, 1959).

Observations were made of 120 groups of chicks six weeks of age or younger. Ten of these with a single age group of chicks were accompanied by more than one hen. In 23 observations single hens were accompanied by more than one age group of young.

Induction of Nest Abandonment by External Stimuli:

During the nesting seasons of 1961 through 1963, experiments were conducted on the Sacramento Area to determine if incubating wild hens could be induced to abandon their nests through stimuli furnished by chicks.

During the three years, 794 pheasant nests were found during June, July, and early August by searching in the most favorable-appearing nesting cover. Of these nests, 588 had been destroyed and 106 contained hatched eggs. Closer observation of the remaining 100 nests showed that 64 had been abandoned. The other 36 nests were used to test the response of hens to (1) the sound of chicks; (2) the sight and sound of chicks; and (3) full association with chicks.

In each of the experiments hens were subjected to chicks which were hatched in incubators or to chicks captured in the field and presumed to be imprinted to a hen (Lorenz, 1937).

Recording thermometers were used at many of the nests to furnish information on the hens' presence or absence.

Effects of sound:

To determine the effect of sound of chicks upon an incubating hen, a wire mesh pen 4 feet in diameter and 1½ feet high was concealed in the vegetation 6 to 8 feet from the nest. Two or three chicks were confined in the pen to ascertain if their peeping would induce the hen to abandon the nest. Chicks were left out day and night with food and water maintained in the pen. Under such conditions, the chicks were very active and their peeping was audible over distances of more than 50 feet. It is believed that chicks emitted only the distress call (Hess, 1959), hence the hens' responses to other calls were not tested.

Five hens were subjected to this treatment (Table 1). None of them abandoned or displayed any observable reaction to the sound of the chicks. At all five nests, chicks were in the pens at the time the eggs hatched and the hens left with their broods. At two nests the hens were subjected to calling throughout the incubation period.

TABLE 1. FATES OF NESTS WHERE HENS WERE SUBJECTED TO ASSOCIATION WITH CHICKS

	Experiment	Control
Treatment: sound of chicks		
Total nests	5	0
Number hatched	5	—
Number destroyed	0	—
Number abandoned	0	—
Treatment: sight and sound of chicks		
Total nests	9	7
Number hatched	1	7
Number destroyed	4	0
Number abandoned	4	0
Treatment: full association with chicks		
Total nests	11	4
Number hatched	0	4
Number destroyed	2	0
Number abandoned	9	0

Effects of sight and sound:

To determine the effect which the sight and sound of young might have on hens, chicks were confined in enclosed wire cages, 2 feet square and 1½ feet high. Each cage was mounted on stakes above the vegetation within 4 feet of the nest and in view of the hen.

Cages containing chicks were erected beside nine nesting hens. Cages without chicks were placed by seven nests as controls. These were checked with the same regularity as cages with chicks, including maintenance of a food and water supply.

From field observations it was evident that sight and sound altered the behavior of the incubating hens. For example, one experimental hen was observed beneath the cage, evidently looking at the chicks inside. Another hen walked from the nest when disturbed instead of flying (incubating hens almost invariably fly from the nest when disturbed). The hens at two nests were undisturbed when the sites were checked for four and five days respectively before young were introduced. However, these hens flushed with care-of-the-young behavior when checked.

Of the nine nests near cages with chicks, four were abandoned, four were destroyed, and one was successful (Table 1). All seven hens in control situations completed incubation and left with their chicks.

Association with chicks:

To determine the effect of full association with chicks, a wire pen about 14 feet in diameter and 1 foot high was placed around the nesting hen. This type of pen was sufficient to confine small chicks but represented only a slight obstacle to the hen. No experimentation was begun until after the hen had left and returned to the encircled nest at least once, suggesting that she did not abandon the nest because of the pen. In 11 pens two to four young pheasants were held to determine their effect on the hen. Hens in four additional pens served as controls and were subjected to the same activity except that chicks were not placed within the pens.

At the 11 pens in which chicks were placed, nine hens abandoned their nests and two nests were destroyed by mammals. At three of these the hens were observed with the chicks and evidently were devoting major attention to them. Two of the hens showed apparently divided attentions, between the chicks and nest. They were observed with the chicks and on the nest alternately. They undoubtedly would have left the nest if the chicks could have escaped from the pen, as they were observed outside of the pen calling to the chicks. One of these hens was on the nest with the chicks at the last observation. Chicks in the pen with still another nesting hen were hatched in an incubator and placed in the pen when one and two days old. Nevertheless, they were with the hen on the nest shortly after they were introduced. Later the hen was calling from outside of the pen. When the pen was raised, permitting the chicks to escape, they responded by going to the hen. The hen did not return to the nest.

In this experiment, action of the chicks hatched in an incubator was different from activity of chicks captured in the wild. Incubator-hatched chicks commonly remained near the perimeter of the pen, continually attempting to escape. In many instances it is doubtful that these chicks made their presence known to the hen except through their calls. However, captured wild chicks (presumably imprinted) usually penetrated the vegetation immediately upon release into the pen and were soon in the vicinity of the hen.

All control hens completed incubation and left their nests with their chicks (Table 1). These four nests were encircled by pens a total of 37 days.

DISCUSSION AND CONCLUSIONS

A hypothesis is proposed that nest abandonment may occur when an incubating hen is subjected to the presence of chicks hatched by other hens and that this abandonment can serve to regulate population density.

Advancement in the reproductive sequence is dependent upon external factors acting through the endocrine system. When a nesting hen is physiologically interrupted or rendered out-of-phase in the nesting sequence, nest failure results. Previous studies have shown that females of other species can be induced to advance prematurely from care of the eggs to care of the young. Experiments reported here showed a similar response by incubating pheasant hens, including altered behavior and abandonment of the nest. The extent of this response reflected the degree of association with the young. A pronounced change occurred when the hen could come in physical contact with the chicks: Nine of 11 hens so treated abandoned their nests. Three were observed dividing their attentions between their eggs and the introduced young before abandoning.

Wheat and roadsides were the cover types of primary importance in reproduction. Roadsides were important for early nesting because of residual vegetation; however, production of chicks in roadsides was not constant but appeared to increase as the density of the vegetation increased. As mentioned previously, this could be explained by assuming that better concealment decreased contacts between hens and chicks, thus, the denser cover permitted a larger number of chicks to be produced before interactions occurred. In this way, variations in the quality of the habitat influenced the level of production.

Cover in wheat was sparse early in the spring and nesting did not occur until the vegetation offered concealment. Production here seemed to be influenced by earlier production in roadsides. This became more meaningful after it was found that wheat was important for rearing of young. Hens, which had earlier produced chicks in roadsides, moved their broods into the wheatfields for rearing. These chicks may have encountered incubating hens causing them to abandon their nests. That associations between unrelated chicks and hens occurred in the wild was demonstrated. During the experimentation, it was apparent that a hen exposed to chicks showed reduced attentiveness toward the nest. This was also observed in the wild.

In 1961, brood studies showed the progress of the hatch was relatively late, and by early summer few chicks were present in the nesting cover. Hens were reluctant to flush from their nests and only one of the seven flushed failed to return. Loss of nests to predators was also very low.

However, in 1963, hatching was unusually early and by early summer relatively large numbers of chicks were present in the nesting cover. Hens flushed from their nests very readily, often while the investigator was a considerable distance away. Eighteen hens responded in this way but only three of them returned to their nests. Predators destroyed a much larger proportion of the observed nests than in 1961.

These observations, together with the experimental evidence, inferred that reduced attentiveness was expressed not only in a higher rate of abandonment, but also in a greater vulnerability of the nest to predators.

This study has provided information that the level of the population of pheasants might be controlled by nest failure prompted by the activities of chicks. It was shown that behavioral mechanisms necessary for its operation exist. However, the demonstration that such nest abandonment actually occurs in nature and at a rate sufficient to control a population remains a subject for future study.

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DISCUSSION

DR. GUSTAV SWANSON (Cornell): Did the controls include the pens and everything else, except birds?

DR. LINDER: Yes. In connection with our controls we made every effort to include everything except the birds, and we attempt to check them often.

MR. ATWELL: Dr. Linder, are you aware of any mortality factors acting on the hen which would liberate the chicks?

DR. LINDER: No, I am not aware of mortality factors which might liberate the chicks. However, we certainly do see a lot of chicks without hens. We also see mixing of broods, and different age groups in one group of birds.

Another point is that very frequently we find pheasant nests where perhaps one or two of the chicks had hatched late, too late to be strong enough to follow the hen when she leaves with her brood. This chick would stay in the nest, and after a time would be strong enough or able to go out on its own and, very frequently we were able to pick up young chicks of this type through their distress call.

VICE CHAIRMAN SADLER: Do you have any observational data in the wild environment showing the reaction of the hen with her brood in the vicinity of a nesting area?

DR. LINDER: Very frequently we would find nests along a roadside, and we would flush birds in the very near vicinity. Our roadsides there are about 15 or 20 feet wide, with a ditch a good fifteen to twenty feet wide. These are used extensively for nesting, and we make our brood counts along the road. Nesting and brooding would be very close to the same area, but as far as seeing reaction of an incubating hen without having used it in our experiments, I have no observation.

MR. SCHUBERT (Fish and Wildlife Service): Were you able to establish a relationship between abandonment and degree of exposure?

DR. LINDER: Well, we were able to establish a relationship when we consider the amount of contact.

For example, with the sound alone, we detected no abandonment. With a combination of sight and sound, I am sure there was a change in the behavior of the hen and, of course, we found some abandonment.

Where the chick was able to actually come in contact with the hen—what we call full association—there we found our greatest amount of abandonment. However, as to the number of days it would take to have a hen abandon her nest, we do not have the data to say very much about that.

MORAL, ETHICAL, AND FISCAL ASPECTS OF WILDLIFE MANAGEMENT

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In order to develop the title of this paper it is necessary first to accept that wildlife management *has* moral and ethical aspects, otherwise the fiscal aspect is without relevance.

Acceptance has been made much easier by the scholarly and richly documented treatment of C. H. D. Clarke (1958) in his memorable "Autumn Thoughts of a Hunter."

The passage of time undoubtedly witnesses an increase, so far gradual, in the anti-blood sports contingent. Its members have not lived entirely in vain since their views have inspired the delightfully irreverent definition of the John Peel type of fox hunt as "the pursuit of the inedible by the unspeakable." However, the dreary Puritan ethic too often shows through—the trait which does not prevent the deed but merely the enjoyment of it and which now and then finds expression in literary journals whose authority in applied ecology parallels that of "Lady Chatterly's Lover" as a textbook on game-keeping.

Over the years I have remained hopeful that someday competent psychological research would be directed at the much-mooted question of whether or not a week or ten days in a deer hunting camp sublimates gross animal impulses which might otherwise lead fond husbands and fathers to beat their wives and harrass their children. Carleton Coon (1954), the distinguished anthropologist, has done a good job of arguing that man evolved, both physically and mentally, above all else as a hunter and that many of the cultural habits and pursuits he has adopted, or has been forced to adopt, in historic times have caused at least some physical retrogression. "Man," he writes, "is a creature fashioned around and selected for hunting." In such a view, we simply perform a devout and worthy sacrifice before the atavistic altars of our race when we hunt or fish.

The sportsman on this continent might have derived some reassurance from a recent cartoon which appeared in *Punch*, the famed humor magazine published in Britain, the cradle of both sportsmanship and anti-blood sportsmanship. This cartoon depicts a somewhat baffled fox hunter astride an equally bemused mount, both watching an aggressive, quarrelsome-looking female parading along the fox trail spraying it with an aerosol solution of scent remover. If the home of the hunt can view such do-gooders with humor, surely all is not yet lost here.

We may agree with Clarke (op. cit), "Hunting remains, as it was in the beginning, completely assimilated to the basic processes of organic nature, in which death and life spring from each other." Or, we may at a much less sophisticated level of introspection simply conclude that man is steeped in sin and that when the human race generally abandons wearing shoe leather and furs and partaking of T-bone steaks, it will be ample time to think about giving up hunting.

Let us grant then that for our present state of development, at least, hunting and fishing are socially acceptable pursuits, threatened less by moral misgivings than by suffocation in man's own unbridled usurpation of the space needed for both the production and the pursuit of fish and game.

Maintenance of the resource then becomes primarily an economic matter and, as with other renewable resources, management is required to maximize returns.

Traditionally, management methods have been aimed at the so-called game species and costs have been borne by the interested beneficiaries, the hunter and angler. It would be unfair to contend that all sportsmen begrudge expenditure of their license revenues on projects where they may be out-numbered by non-consuming recreation seekers. And, it would be less than accurate to assume that these non-hunting users of hunter-purchased lands would uniformly resist being asked to pay their way. Furthermore, facts do not always support the charge that wildlife managers ignore the problems and welfare of other than game species.

Let me cite examples from my home state of Michigan. The Rifle River Area, a 4,300-acre tract, was acquired by the Department of Conservation twenty years ago with monies from the Game and Fish Protection Fund, an earmarked repository for license revenues. Considerable additional sums were invested in game and fish management projects, chiefly habitat manipulation and, while sight-seers were not barred, roads were maintained only to minimal standards and overnight camping was not permitted. Yet, within fifteen years, sight-seers and other non-consuming users of the area outnumbered sportsmen two to one. Even then there was no significant display of resentment by hunters and fishermen: ultimate redesignation of the tract as a state park stemmed not from this cause but from pressure by businessmen in the community who were confident that state park status and park-style developments would greatly stimulate the local economy. (Ensuing reimbursement of the Game and Fish Protection Fund for a part of the purchase price was due to legal technicalities, not to sportsmen's outcry.)

On the other side of the coin is the appearance of a plea (Butsch, 1960) in the journal of the Michigan Audubon Society strongly urging its members to buy hunting licenses they might never use simply because this was about the only orderly medium through which they could contribute to programs of land acquisition and development—programs geared to game production and harvest which could not help but benefit nongame wildlife populations as well.

Finally, there was the action of the Michigan Conservation Commission in 1955 establishing some 7,680 acres of state forest land as a preserve for the Kirtland's Warbler, where forest management practices would be directed primarily at maintaining ideal nesting habitat for this rare and choosy songbird, an action followed by the U.S. Forest Service's dedication of an additional 4,000 acres for this purpose in 1962.

No doubt many examples could be found elsewhere of this willingness of sportsmen, non-consuming outdoor recreation seekers, and wildlife managers to share or at least tolerate each others' viewpoints. But the problem is growing. Clawson (1964) has noted ". . . . if there has been a 'population explosion,' there has been a recreation explosion five times as violent. Camping [and] water sports . . . . have experienced particularly rapid growth; they have generally been on a family rather than an individual basis."

This trend is visible in many quarters: membership in the Audubon Society has grown faster than the sale of hunting and fishing licenses in the past decade; the sale of high horsepower outboard motors, obviously intended for water-skiing and other high speed uses, has far outstripped that of equipment appropriate to trolling; in some states such as my own, known use of state parks and state forest campgrounds has soared while license sales have held steady or even declined.

The fact that family-oriented, non-consuming uses of outdoor recreational space and facilities are growing much faster proportionately than hunting and fishing poses new and critical problems for the wildlife manager. Just as he is being confronted with new threats to wildlife resources such as uncontrolled dredging and filling, pesticides and other pollutants in both lethal and sublethal concentrations, and hitherto unimportant diseases as exemplified by the die-off of loons and other water birds in the Upper Great Lakes due, as many of us are convinced, to Type E botulism, his sources of financial support are dwindling in terms of total customer demand, and because of the shift in customer interest he may have trouble communicating the extent and nature of his needs to those who control the purse strings.

It is clear that responsibility must be accepted and support granted by all outdoor users for the maintenance of ecological integrity and quality.

And, as other than hunting and fishing uses come to dominate, planning and decision making regarding outdoor resources may be expected to pass to other hands which may be hostile or at least oblivious to sportsmen and their interests. Today leadership in outdoor recreation is being claimed by the whistle-blowers and the interests categorized as "organized sweat." There is nothing wrong with the intensive type of space development planned by physical education enthusiasts or by social scientists. But there is presently little mutual understanding between them and our own interests.

The wildlife manager today confronts the greatest challenge his profession has hitherto faced. His professional competence and responsibility must expand to embrace enough of the myriad varieties and orientations of outdoor resource users for him to communicate effectively with both users and the new breed of decision-makers. Only by accepting and meeting this challenge can he be true to his profession and effectively support the interests of his traditional clients.

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TECHNICAL SESSION

Wednesday Morning—March 10

Chairman: KEITH G. HAY
Recreation Resource Specialist, Bureau of Outdoor Recreation, Denver, Colorado

Discussion Leader: CHARLES H. CALLISON
Assistant to the President, National Audubon Society, New York City

CONSERVATION INFORMATION AND EDUCATION

REMARKS OF THE CHAIRMAN

KEITH G. HAY

This morning Mr. Callison and I want to present to you a program that is a little different than the pattern in the past. We attempted to do this in the selection of our panel. We wanted to break out of the old pattern of a group of professional conservationists sitting around talking to each other. We wanted to obtain some fresh blood, some new ideas, so we sought the services of some of the top people in the communication and public relations field as well as some of our top conservationists.

Our getting together a panel of this nature was not easy, but I think that all of our efforts will be repaid by the advice and counsel these men will have to offer this morning. Certainly putting together such a panel is no one-man job, and I would like to personally and publicy express my appreciation, first of all, to my discussion leader, Mr. Charles Callison, assistant to the president of the National Audubon Society who helped me immeasurably in getting the panel together; Mr. Bob Hutchins who was also of great help in getting many of the members; and to Mr. Frank Gregg who gave me many good suggestions.

THE ROLE OF NEWSPAPERS IN PROJECTING CONSERVATION THOUGHT

EDWARD J. MEEMAN

Conservation Editor, Scripps-Howard Newspapers, Memphis, Tennessee

Is there a newspaperman in the room? A reporter, a copy reader, a managing editor, an editorial writer, an editor, a publisher? I congratulate you on your opportunity and your responsibility.

You have the indispensable periodical, the one the citizen cannot do without, therefore you have the most influential form of the printed word. That is because the period of time in which you publish is the most dramatic division of time in human experience. The month and the year come and go almost imperceptibly. The week is a mere arbitrary division of time. But if the sun does not come up "like thunder 'crost the bay" everywhere, as in Mandalay, its rising and setting everywhere do bring a sharp change in the human scene. Our work and our play are all governed by the coming of morning and the coming of night.

Because the daily newspaper has this dramatic division of time, the day, it is the essential publication. Because it is the essential publication, it is the center of communication of all the elements of society—labor, agriculture, business, the church, schools, colleges, the theater, radio, television, literature, social and philanthropic organizations, foundations, political organizations, and government in all its branches, local, state and national. The daily press is the forum even of the nations. To the press all these elements come to report themselves and be reported, to criticise each other and be criticised. To the press they come for that understanding and appreciation which all things human crave, and which they should have if they are to be effective and happy.

Some newspapers fully embrace this golden opportunity and assume this awesome responsibility. Some do it inadequately. A few seem unaware of it. But whether the job is well performed or not, it belongs to the daily newspaper, it cannot be passed to any other institution. Our society will function only imperfectly, it cannot become the great society unless the newspaper's job is performed in a spirit as large as the task itself.

In saying what I have said, I do not in the least intend to disparage or belittle the other means of communication. That would be vain if I wished to do it; I do not.

For who is not aware of the magnificent performance of electronic journalism, radio and television, which often shames newspapers by its completeness; who has not been grateful for the t-v documentaries, which are sometimes fascinating feature stories and sometimes bold crusades, which I have usually found scrupulously fair and searchingly thorough? Since we are discussing conservation, I remember especially the one on our national parks; and right here and now I will express the hope that the same sponsor will present a similar one on our state parks.

And who has not admired our magazines, which are not only beautiful in appearance but manage to be fresh and lively and often to carry big news scoops, despite the necessary time lag between preparation and delivery?

It is not a matter of greater or lesser, of superior or inferior, but of the position occupied and the function proper to it. The point I make is that newspapers occupy the center of communication, and they should occupy it fully and grandly. Moreover the newspaper is the periodical of record.

"Were it left to me to decide whether we should have a government without newspapers, or newspapers without a government," said Thomas Jefferson, "I should not hesitate a moment to prefer the latter."

The newspaper which is completely fullfilling its function under Thomas Jefferson's dictum to be more indispensable than government, the complete newspaper, will print all the news. We must immediately qualify that. In this time of multiplying nations, of multiplying population with multiplying problems, no newspaper, not even the New York *Times,* can print "all" the news. It can and should give a report of happenings complete enough to satisfy the natural and decent curiosity of a normal citizen. It can and should give sufficient information, interpretation and background to enable a college graduate with a B average to form a working opinion on public affairs and enable him to vote intelligently. None of this essential news and background should appear in only one edition, but every edition should contain all the news of the preceding 24 hours. Democracy requires leadership, and this must come from newspapers among others, some of the others being politicians—and I use the word respectfully—divines, philosophers, professors, foundations, and electronic and magazine journalists as well. This newspaper leadership should appear in the editorial columns, but it should also appear in purposive, although fair and objective, studies and exposures in major articles or series of articles exploring situations in depth and detail by writers who are not only reporters, but digging investigators and scientific interpreters.

Any leader in modern democracy, and the leader we are thinking of here is the newspaper, will immediately recognize that the No. 1

problem is to save civilization from atomic destruction by averting World War III, striving to stamp out the little blazes which are constantly being lit all over the globe lest they set off the big blaze. He will not hesitate to put up there with No. 1 another purpose, the purpose of saving Nature from ruthlessly advancing indiscriminate technology. For of what avail a civilization barren of its natural beauty? As Vice President Humphrey said here Monday, what greater duty has man than to preserve the works of our Creators.

The newspaper dedicated to the saving of Nature will print all the news of conservation. Its editorial writers will comment on every major conservation question. It will have an Outdoors column on its sports pages. It may also have a Conservation column on its editorial page, and perhaps a bird column and a garden column somewhere. Its cartoonists will emulate Ding Darling. It will not color the news but will, as Roy Howard asked, give the news its own color, for the news is not drab and gray, as some news writers misrepresent it, but bright with blue and green, and red and yellow. Even an honest purple passage can have a royal dignity. And not only the figurative color which the right words arranged in inspired relation to each other on the black-and-white page, but the literal pigment on the color pages can serve the cause of conservation.

What newspaper will be the first to have a conservation council? This will consist of the editor, the managing editor, and one or more of such persons as editorial writer, the sports page columnist, the woman's club editor, a star investigative reporter—you name him; the council would not be the same on all newspapers, but differ with differing set-ups and differing personnel. The council would meet in the editor's office once a week, preferably at a given time, so the meeting would never be cancelled, but would be held regularly even when "everybody is busy," and even when the editor was out of town. I would suggest a strict limitation to 15 minutes. That would be sufficient to accomplish the sole purpose of the meeting, which in general, would be to keep high the unflagging purpose of the newspaper, which is to win the conservation battle, and in particular to determine what are the battlefronts in the particular week to come. At one time it would be a legislative fight in Washington. At another, a convention of a North American Wildlife Conference, a meeting of National Wildlife Federation, the Audubon Society or the Izaak Walton League, or the Wilderness Society, or the Nature Conservancy, or the National Conference on State Parks, with instructions to be given to the telegraph editor to be sure that he would look at every piece of copy concerning the conference that came over the wire, use all that was good, and if enough was not coming to ask the press association for better coverage. Another week it might be to report a hearing at which citizens were protesting a proposed dam in a wild river. Best of all, it might be the paper's own fight to save a natural area or to keep a highway from bisecting a park, or to keep a local government from putting a public building in a park on the goofy theory that "we already own the land, it won't cost us anything."—

Those are just a few of the things a newspaper can do.

That is what can be accomplished through a newspaper starting from the inside.

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What can be accomplished thru a newspaper starting from the outside?

A conservationist can accomplish much working with a newspaper, if he is thoughtful, tactful and patient; persistent, but always pleasantly so.

If you know no one on the newspaper, go to see the editor, managing editor, or editor of the editorial page, as the case may be. If you know someone on the newspaper, ask his guidance on who to see, or obtain an introduction thru him.

Before you go, think out what you are going to say, so your statement will be clear and you will not repeat yourself, which not only wastes time but deflates emphasis. Having stated your case, await questions. When it is indicated that the exchange is over, leave with a thank you and a smile, and your next visit will be welcome. So come often, but briefly each time.

You can usually go straight to a columnist to get his co-operation. He usually determines what he writes, and he will respond far more readily to a request or suggestion made to him directly than to one that may be relayed to him thru his boss. Washington correspondents, too, can usually best be approached directly.

Also there are individuals in local newspaper offices other than the official yes-no men who are often quite influential. Many first class reporters can make their own assignments. When you find such, keep in touch with them. Send attractive brochures to the editor at his home. I know what it meant to me as editor to receive "The Green Legacy" and the publications of the Sierra Club.

Conservation is not a bill of goods to sell. It is a cause to which to win people. Let us not make the mistake that we are a little closed company of select people, who know how to talk to each other, but that our concern about vanishing nature is not something that men of ordinary clay can understand. Expect that the man you are going to see has feelings as sensitive as yours, and can rise to America's great need to save its vanishing wildlife when you present it to him.

But don't ask him to print dull stuff. He won't print it, because he knows his readers will skip it, and so it wouldn't do our cause any good if he did. Give him animal interest or bird interest, human interest, or blooming tree interest, or pure air interest, or white sand interest or rushing water interest, or all these interests in one, for they have universal appeal, and more every hour. For interest in conservation is a rapidly rising tide. Let's take it at the flood; it leads to fortune for our cause.

A conservationist or a conservation organization working alone can do much. Officials working alone can do much. A newspaper working alone can do much. Any two of these working together can do more. All three of these working together can accomplish anything! Try to form such an alliance; it has often been done.

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Here is a conservation task that needs to be done everywhere. That is to get conservation effectively taught in the schools. Nothing could give us greater or more secure progress in conservation.

That need was well stated by the newspaperman who, at your conference in Las Vegas last year, occupied the spot I occupy at this one, R. G. Lynch, former natural resources writer for the Milwaukee *Journal.*

Mr. Lynch pointed out that his own state of Wisconsin has been a pioneer in conservation education, and does a better job than most states, but that the results are far from satisfactory. In Wisconsin, as in most states, he said, conservation is integrated in regular courses. But he found that history teachers had tried to get themselves relieved of conservation teaching—it did not "belong" in a history course, and he asked you, and I repeat his astonished question:

"How could anyone teach history without dealing with the use, abuse, and competition for natural resouces that has gone on as far back as we know what happened on this earth?"

I find that a good answer to most arguments is this: "Not either—or" but "both—and." Let us have in our schools specific instruction in conservation as a special subject and in chapel lectures and pictures. But let us also integrate it into every other subject. For conservation is a matter of life or death. A local conservation organization could do nothing better than appoint a qualified, responsible committee to make a continuing study of conservation as taught in its schools. Or several organizations could appoint a joint committee. If there was no conservation teaching, it could ask that such teaching be introduced. If it existed, it could be improved. We know it is not good enough anywhere; improvement of conservation education is a universal need.

FitzGerald Bemiss, chairman of the Virginia Outdoor Recreation Resources Study Commission, has suggested that engineering colleges require all engineering graduates to have had a course in conservation and landscape design. If that is accomplished, it will not take a fight to keep roads out of wildlife refuges and parks. Won't you join Mr. Bemiss in this, and ask your own colleges and universities to make this requirement? I have found that college presidents will lend a willing ear to such a plea.

Citizens working for conservation alone can accomplish much. Officials working for conservation alone can accomplish much. Newspapers working alone can accomplish much. Any two of these working together can accomplish more. When all three work together they can accomplish *anything*. Get together!

DISCUSSION

DISCUSSION LEADER CALLISON: I am sure you can see that Ed Meeman was a dynamo as an editor. The remark that Keith Hay made when he introduced him, that he surely must have been an editor since the turn of the century, grew out of our amazement yesterday to learn of all the things this man has accomplished and still be as youthful as he is.

I am further amazed that he can stand up here and deliver this very complete and practical talk to us without a note in front of him. He said, "Just give me a signal when I have five minutes left so I don't leave anything out."

Of course, no one can cover the ground in 15 minutes and Ed Meeman would be the first to agree. So now we have an opportunity to add thoughts or direct questions to Mr. Meeman.

MR. SHERMAN BURMAN (BLM): I would like to offer this thought that perhaps too much of our attention is focused on the special columns, the outdoor columns and the garden columns and not nearly enough do we think of conservation as news, as Mr. Meeman stated we should.

An example of this is the coverage which this conference has received from the Washington papers. It has been very poor. It has not been regarded as major news. It has not been thoroughly covered. Monday's general session with the Vice President and Senator Kuchel talking, received three or four inches back in the second or third section of the Washington *Post*. I would think this is a major area we have to attract, to think ourselves and to get the newspapers to think of conservation as major news.

MR. MEEMAN: I agree entirely with that and one thing to do is to call briefly on the managing editor in advance of the meeting and sell him with brief but great enthusiasm on the wonderful program coming up and the news that will be in it. As you say, this has been most inadequately covered.

DR. BUCHINGER: I would like to call attention to the coverage of international conservation groups. Sometimes they mention a conference if there is a disaster. For instance, a drought of some sort, a big area is without water. Even then you don't find it to be covered adequately.

DISCUSSION LEADER CALLISON: I believe the lady's comment is, and I think you will want to respond to this, that this is not recognized as international news.

MR. MEEMAN: I know of the splendid pioneering work that Dr. Buchinger is doing. She has her office at the Nature Conservancy. Dr. Buchinger and her associates are working on a tremendous program for Latin America, a national park in Peru, a great national park that will be world famous. I talked yesterday with the man working on the exhibit for the 75th Annual Anniversary of the Inter-American Movement. It is going to be an exhibit going over the country. I am sure it will be recognized.

Africa is getting attention; not too much. But to think that Latin America with its magnificent wildlife is now at the critical point and it should have all of our interest, not as Dr. Buchinger said, just the interest of the newspapers, but it should have the interest of all conservationists to get back of the work that is being done. It is a new field, a tremendous one. She is so right.

BROADENING THE BASE OF CITIZEN SUPPORT FOR CONSERVATION

FRANK GREGG

Executive Director, Citizens Committee for the ORRRC Report, Washington, D. C.

It has been said of the military that its leaders customarily spend the period between wars preparing to fight the last one.

Conservationists have endured no such slanders to date. But we are going to have to move pretty briskly in the years ahead to take advantage of the new opportunities available to our profession. And among the new opportunities we'll most want to grasp is that of broadening and strengthening the foundation of public support for conservation action programs.

It's difficult to grasp how quickly the conservation outlook has changed.

In the traditional areas of conservationists' concern, here are a few of the accomplishments of the first half of the '60's:

—we have a National Wilderness Preservation System and a good prospect of expanding it;

—we have, through the Land and Water Conservation Fund, a comprehensive program of Federal aid to States and local governments to plan and acquire and develop resources for outdoor recreation;

—we have a well-established Federal program to help get waters clean, an excellent prospect of upgrading and strengthening the program this year, and a good chance for a redoubled Federal effort before this Congress adjourns;

—we have the framework for a significant wetland acquisition program (although we've had little success in implementing it);

—we will get in this session of Congress a Water Resources Planning Act which should improve the quality of Federal water resources planning programs, improve coordination among Federal agencies

and strengthen the role of the States in river basin planning;
—we've made a number of additions to the National Park System and the new National Recreation Area System and can expect to add more, with financial help from the Land and Water Conservation Fund;
—we have seen a great upsurge of State activity on behalf of outdoor recreation and open space, beginning with New York's $75 million bond issue for land acquisition in 1960 and continuing through California's $150 million bond issue in 1964.

With these and other strides, the nature of the traditional conservation challenge has been fundamentally altered. We now have the opportunity to achieve many of our priority objectives. We are no longer a minority. We have asked for, and received, the confidence of the Nation.

This fact gives the conservation movement a heavy measure of responsibility—to show the same unity and sense of purpose in exercising our new authorities that we have in demanding them.

The plain truth is that in the traditional conservation fields, the next few years will demand a higher quality of leadership than has yet been asked of us.

At the same time, conservationists are being summoned to provide leadership for another series of conservation issues of comparable magnitude.

The "new conservation" was outlined by President Johnson in his splendid message on natural beauty:

"The increasing tempo of urbanization and growth is already depriving many Americans of the right to live in decent surroundings. More of our people are crowding into cities and being cut off from nature. Cities themselves reach out into the countryside, destroying streams and trees and meadows as they go. A modern highway may wipe out the equivalent of a fifty acre park with every mile. And people move out from the city to get closer to nature only to find that nature has moved farther from them.

"The modern technology, which has added much to our lives can also have a darker side. Its uncontrolled waste products are menacing the world we live in, our enjoyment and our health. The air we breathe, our water, our soil and wildlife, are being blighted by the poisons and chemicals which are the by-products of technology and industry. The skeletons of discarded cars litter the countryside. The same society which receives the rewards of technology, must, as a cooperating whole, take responsibility for control.

"To deal with these new problems will require a new conservation. We must not only protect the countryside and save it from destruction, we must restore what has been destroyed and salvage the beauty and charm of our cities. Our conservation must be not just the classic conservation of protection and development, but a creative conservation of restoration and innovation. Its concern is not with nature alone, but with the total relation between man and the world around him. Its object is not just man's welfare but the dignity of man's spirit."

With this message—uniting traditional conservation objectives with programs to make our urban areas livable under a broad "quality of life" theme—the President and his principal lieutenant in this field, Stewart Udall, have inaugurated a fundamental and permanent change in the conservation agenda.

The "new conservation" does not signal a turning away from the traditional conservation arena. On the contrary, it calls for applying the experience and confidence, the crusading spirit and the stamina of conservation leadership to a broader range of objectives—to the quality of the total physical environment, and ultimately to the character of the American people.

The "new conservation" invites a redefinition and broadening of the conservation movement. It makes natural allies of we who have worked to conserve our natural resources wherever they are found, and those who are concerned with the character of our urban areas. It offers the opportunity for a comprehensive, coordinated national program to protect and enhance the quality of the environment, from urban centers to wilderness—and of a corresponding broadening and strengthening of a citizen involvement.

Or to put it more callously, the "new conservation" gives us an opportunity to build a conscious working partnership between the "conservation lobby," park and recreation interests and spokesman for our metropolitan areas.

If we recognize and respond responsibly to this opportunity I believe we can convert the current surge of public conservation awareness into a permanent element of the American consensus.

And—given the pressures of a growing industrial society—we must have such a consensus if we expect to provide a decent environment for our heirs.

At this point I should waive any claim to revelation in this somewhat ponderous analysis. Others have recognized the essential unity of conservation's work for decades—with Aldo Leopold as the inspiration for most of us in this room.

And I should note that the new alliance is already building. The water pollution wars brought municipal and county officials and their citizen and Congressional supporters in effective alliance years ago.

Conservation interests joined with urban spokesmen to help enact, in 1961, the program of Federal grants for urban open space acquisition administered by the Housing and Home Finance Agency.

Professional organizations concerned with the appearance and sound quality of urban areas are organizing to better serve the "quality of environment" cause. The American Institute of Planners, American Institute of Architects, American Society of Civil Engineers, American Society of Landscape Architects established last year an inter-professional commission to work for better urban environments. The Consulting Engineer Council and the National Society of Professional Engineers have since joined in this effort. (Of course, landscape architecture has long been a productive meeting ground for the design and conservation professions—Art Carhart is a pioneer example.) At a meeting in January of this year one of these professional organizations—AIP—adopted a position on open space that recognizes a city-to-wilderness responsibility of the planning profession.

A new focal point for coordination of urban environment with conservation and park and recreation interests may be provided by the American Planning and Civic Association. This venerable citizen organization has for decades attracted leaders of both the conservation and city planning fields. APCA has recently received financing for a broad program of public education on behalf of what it calls the "visual environment," and it will apparently be accepted by the urban-oriented design fraternity as the lay leader in the field.

In the park and recreation field, after years of wasting controversy, citizen and professional organizations appear to be moving toward a merger. The proposed new National Recreation and Parks Association, comprised of the National Conference on State Parks, American Institute of Park Executives, American Recreation Society, and National Recreation Association, should strengthen the park and recreation movement and provide a focal point for coordination with traditional conservation interests and urban interests.

The general surge of interest in outdoor recreation has helped mightily to lay the groundwork for the "new conservation."

ORRRC recognized the need for a balanced range of recreation resources ranging from city playgrounds to the great scenic treasures, and focused special attention on outdoor recreation needs in metropolitan areas.

The Bureau of Outdoor Recreation's program is a strong stimulus to comprehensive conservation planning and action.

The Land and Water Conservation Fund bill—with its provisions for grants-in-aid to both State and local governments—will help provide for that balance. It should—and this is important—strengthen the national constituency of the Department of the Interior by providing effective ties to city and county as well as State governments.

At the State level, outdoor recreation—through the Land and Water Conservation Fund program—provides a vehicle for immediate cooperative effort.

To qualify for acquisition or development grants from the Fund, each State must prepare a comprehensive statewide outdoor recreation plan.

The plan must be comprehensive in the range of outdoor recreation resources it covers, and the range of activities these resources are to provide. The plan must take account of the programs and potentials of each level of government—city, county, State, Federal—before it will be approved. And local governments can qualify for grants only for projects consistent with the statewide plans.

These statewide planning programs can be a powerful stimulus to the development of coordinated, comprehensive conservation programs—if the States see the planning requirement as an opportunity to broaden their constituency, and thus public support, for imaginative long-range programs in which each level of government meets a share of the total responsibility.

Most States see the opportunity clearly—Bill Towell and Mel Steen come to mind as administrators who are taking the long view. And in at least a few States, leaders of private conservation organizations are establishing new relationships and new vehicles for combining conservation-urban support for comprehensive programs.

An example is the fledgling Colorado Open Space Council. The Council is an inter-organization committee in which fish and game and wildland enthusiasts have joined with broadly-based civic organizations (such as women's clubs) and urban park groups (such as the Denver area's Regional Parks Association).

The Council will have staff. It intends to work to strengthen the efforts of existing organizations—not compete with them for public attention, membership or funds.

Temporary inter-organization committees worked well in uniting conservation-park and recreation-urban interests. You'll get a good case history from Ray King, who headed the citizen effort to win support of California's recreation bond issue in 1964.

The alliance is also working at the county level.

Through the leadership of the National Association of Counties, the Nation's counties have accepted the responsibility to help meet open space, outdoor recreation and other natural resource needs. You may expect to find—and you can help stimulate—a better response to conservation needs in counties in the years ahead.

A specific opportunity for cooperative effort at the county level is the county recreation survey project of the National Association of Soil and Water Conservation Districts. NASCD has provided survey forms for use by individual districts to inventory and evaluate recreation resources—to find out what is available and what is needed, and to suggest guidelines for action. Both citizen groups and public officials will have opportunity and incentive to help with these surveys. Many of them may form the basis for sustained county conservation planning programs.

At the municipal level effective leadership is being provided by the U.S. Conference of Mayors and the National League of Cities (formerly American Municipal Association).

And we can expect a powerful thrust to action opportunities, and useful information on the techniques of cooperative action, from the White House Conference on Natural Beauty to be held in May under the chairmanship of Laurance Rockefeller.

With handholds such as these it seems hardly necessary to draw conclusions.

Conservationists have long accepted as a basic article of faith the interrelationship of resources and the community of living things. We've called it ecology, or the web of life, or simply conservation, and we've urged that the concept be recognized in public policy.

Now the political leaders of the land are articulating this concept, and outlining a comprehensive action program consistent with it.

We are no longer, in short, prophets without honor. Nor need we pursue our special objectives in isolation.

The same public conscience which cries out for livable cities can be aroused to the preservation of wildlife habitats. The hard core which led the wilderness fight will respond instinctively to the preservation of parks and small islands of nature in the metropolis. The man who has led a drive to conserve a watershed is no stranger to the need for clean water—or to the public yearning to enjoy it.

And the woman—bless her—who is offended by billboards can be a tenacious fighter for sound development of suburban communities.

The implication is obvious. We—whether our responsibility is for fish and game, livable cities, wildlands, parks, water, spacious suburbs, soil, forests, forage, playgrounds, pleasant highways—are working for the same objectives.

We shall do well to recognize our common purpose, and to build upon it. Your own imagination will suggest ways to do so, but we can begin—

—by preparing our plans and our programs in the context of the total "quality of the environment" objective—beginning with the comprehensive statewide outdoor recreation planning programs;

—by relating our own plans and programs to the total objective in speeches, magazines, newsletters and other information and education media, and by giving appropriate coverage to urban environment and other elements of the "new conservation";

—by getting to know and developing effective working relationships with officials and staff people of State and local organizations and agencies interested in urban design, planning and development—citizen organizations, professional societies, leagues of cites and counties, elected officials, members of boards and commissions;

—by breaking the jurisdictional and philosophical barrier which has too long separated fish and game interests from park and recreation interests;

—finally, by welcoming into the inner (and too often exclusive) circles of conservation leadership at every level representatives of the urban environment and park and recreation movements.

* * * *

Our Committee—the Citizens Committee for the ORRRC Report—was established, as many of you know, to encourage the kind of cooperative action that I've discussed in this paper. We've worked with the national offices of the urban environment and park and recreation groups listed in this paper. We've found them all responsive and helpful. Two booklets published by CORC—"Action for Outdoor Recreation for America" and "County Action for Outdoor Recreation"—both suggest ways for citizen groups and public officials to work responsibly together for comprehensive "quality of the environment" programs, and both give names and addresses of the principal organizations in the urban environment and park and recreation fields. We'll be glad to send copies to those who may not have seen them.

DISCUSSION

DISCUSSION LEADER CALLISON: Frank Gregg is a skillful tactician who has the unifying mind of the generalist. Do we have some reactions to his ideas?

MR. JIM KEEFE (Missouri Conservation Commission): I would just like to underscore what Frank said, that there is a great deal of interest in the outdoors now, a real ferment, and these new organizations and maybe some not so new ones are seeking our support.

Recently in Missouri, for instance, the St. Louis County Planning Commission which recently had concerned itself with its own bailiwick—in fact, St. Louis believes Missouri ends just about five miles outside the city limits—has solicited our interest and publicity and recognition.

More recently and even more oddly to me, was the Missouri Council on the Arts which wrote our department and asked for our endorsement and interest and support and asked where they might help us. This kind of caught us with our breeches down, because we hardly considered ourselves part of the arts. We got to thinking and suggested maybe the integrity of the outdoors, the natural environment itself, was an art form or at least worthy of recognition by the Council on Arts designed to make Missouri a more livable place. They were delighted with this idea and they sponsored it.

MR. GREGG: Missouri, always one of the leaders, has done a very interesting thing. This is not new, but Bill Towell has done a good job of it, and some of you might want to remember this. The governor has set up, at Bill's suggestion, a governor's conference on outdoor recreation, which is going to be held in April. Bill has seen the opportunity in the Land and Water Conservation Fund Act and its requirement for statewide planning clearly. I have talked to him about it several times, to provide a program in which urban people, those with esthetic interests, the fish and game people can participate. In every element of government there is an opportunity in this program which is important to them.

He set up an excellent conference to bring all these people into the same room at the same time and to lay the framework for a sound, sustained, comprehensive conservation program. Missouri would welcome any of you from neighbor states who might wish to come. Jim, do you have the dates of that governor's conference?

MR. KEEFE: April 8 in Jefferson City.

MRS. ARTHUR FENSKE (Great Swamp Project in New Jersey): Mr. Gregg suggested that we allow municipal people to join the inner circle of the conservation movement. I would like to suggest that women ought to be also represented within the inner circle a little more than they have been.

MR. GREGG: Well I have always thought we had a very close relationship. [Laughter] I think most of us still tend not to give the deliberate effort we ought to to strengthening relationships with a broad range of women's organizations. But at least at the national level and, I think, in most of the states, we all consider the garden clubs, the women's federation groups, the League of Women Voters to be a part of the hard core. There is no question but what that is so and is very important.

MRS. FENSKE: I realize this, but nowhere in this conference have I seen women represented and I think it would be a broadening aspect and it would harness a tremendous enthusiasm.

DISCUSSION LEADER CALLISON: That is a very good and timely suggestion and we will see that the Wildlife Management Institute, the organizers of this conference, hears about it.

I think it is perhaps a sign of the maturity or the maturing of our society and perhaps a sign we are on the road to a great society, that tough old game law enforcement men like my old friend Vernon Bennett of Missouri and a weather-beaten old forester, will now stand up publicly and say the words, "natural beauty" out loud and clear without feeling there is something a little sissy about that expression. In fact, not all of us have gotten to that point, because some of my old associates in the game and fish work, are a little timid about the importance and the meaning, and the power of those words, what they signify and what we are trying to do in this country. But the President of the United States who, I guess, has a rough and tough background himself, recognizes it as something very important and of great popular appeal, and of great public need in this country.

OVERCOMING PUBLIC APATHY IN FINANCING OUTDOOR RECREATION

HENRY RAY KING[1]
California Department of General Services, Sacramento

California with a burgeoning population of 18 million and an influx of nearly 50,000 people monthly, has been faced with recreation demands that far exceed its existing facilities. The need for improvements and expansion in our beaches and parks had reached the point of a "recreation crisis." To alleviate this condition, a major bond issue was proposed in 1962. The resulting proposal was resoundedly defeated in the election of that year.

In the fall of 1963, renewed efforts were initiated to once again achieve the objectives defeated at the polls a year before. We knew the road ahead was not an easy one. The citizens had already said "Nay." Our job was to reverse that mandate and we knew this difficult, but not impossible, task would involve a full year of our best efforts. "Californians for Beaches and Parks" was thus organized with its single purpose—to overcome public apathy and win approval of a $150 million outdoor recreation bond issue.

The following is a brief account of the organization and methods employed in the conduct of our successful campaign and its million and one-half vote margin of victory. The techniques we used in California would, of course, require adaptation to the many political, economic, population, and related situations that another State might possess in conducting such a campaign.

ORGANIZATION AND FUNDS

The decision to devote a full year to the campaign gave us a decided advantage. We could make long-range plans, lay the groundwork, and make the myriad of contacts that are so important. Originally, our plans called for a $254,000 budget and a staff of two secretaries, one assistant and an executive director. The assistant would work full time in southern California where the bulk of our population lies. Considering the size of California, its population centers, and a presidential election year, such a budget and staff were well within reason. This budget, unfortunately, was not reached and we worked with an actual budget of only $153,000. Our staff, thus, consisted of myself as executive director and varying secretarial assistance.

The budget was raised entirely through volunteer contributions.

[1]In the absence of the author, owing to illness, this paper was read by Chairman Kieth G. Hay.

Contributors were sportsmen's groups, individuals, corporations, etc. The sportsmen were interested in the bond issue because it included $5 million for wildlife conservation improvements.

One of the most important duties in the inital organization of the campaign was the selection of a board of directors. Our main purpose, here, was to get a "name" committee, composed of substantive individuals who were influential and well-known. We were fortunate in obtaining the services of the following: Mr. Walt Disney, Governor Brown, former Governor Knight, the president of the California Parent Teachers Association, the president of a large life insurance company, the secretary of the Teamsters' Union, the president of the County Supervisor's Association, the President of the League of California Cities, a municipal court judge, a publishing company executive, a prominent citizen of Los Angeles, the president of the AFL-CIO. The names of our board of directors were very familiar to the people of California. And, obviously, when you have a major organization endorsing you, you try to get their president.

Governor Brown, a Democrat, and Ex-Governor Knight, a Republican, were co-chairmen of the Board of Directors. We, thus, immediately removed the element of partisanship from the bond issue. This had formerly been a major problem in California because the republicans had been opposed to bonds as a method of financing. the Republicans had been opposed to bonds as a method of financing. former U.S. Senator William Knowland, who had been chairman of the Park Commission for 25 years. This action very effectively cut into the conservative Republican opposition.

We recognized the need for representation of minority groups by having a Negro and a Spanish-American on the board. Both of these minority groups represent large voting blocks in California. When selecting board members, thought was also given to geographical balance so that someone from every major voting area was included. We wanted a voice in each area even though that voice might be in name only. The board of directors met approximately three times. The finance committee met frequently, however, to plan its constant fund raising activities.

A small Steering Committee was also established. This committee was composed of a California Park Commissioner, a Recreation Commissioner, a member of the State Senate and a member of the State Assembly, the head of the Resources Agency, and a representative of the County of Los Angeles (because this county is the largest in population in the State). This committee also had a northern California chairman who was a former chancellor of the University of California and a southern California chairman who is president of a large bank. Mr. Harold Zellerbach (of Crown-Zellarbach Corporation) was finance chairman and treasurer of this committee. He, in turn, had a prominent businessman acting as southern California treasurer.

CAMPAIGN METHODS

One of the major objectives of the campaign was to overcome the opposition—both past and present. In most cases, we were able to get the various groups and organizations to endorse the bond proposal which was called Proposition No. 1. When this was impossible, we suceeded in most instances in preventing their active opposition.

Considerable personal contact was used in achieving this objective, not only by myself, but by the various members of the Board of Directors and Steering Committee. Contacts were made with influential members of the communities, the Chamber of Commerce board members, the heads of civic organizations, ets. We participated in various conventions and succeeded in getting them to go on record as endorsing the proposition through their resolutions. A broad cross-section of endorsements resulted, including the California State Chamber of Commerce, the California Junior Chamber of Commerce, the PTA, the Teamsters, as well as the AFL-CIO.

We also established a speakers' bureau of approximately 200 people. A Disney film, which I will mention later, was made available to all of these speakers.

NEWSPAPER, TELEVISION AND RADIO

We produced and mailed press releases to newspapers just as fast as our mimeograph machine could be cranked. In all major California counties, we set up "County Committees" with chairmen who were key people in their communities. These chairmen, both Republicans and Democrats, assisted in producing stories on the bond issue for local consumption. In addition, over 25 editorial conferences were held with virtually every major newspaper in the State.

The lack of money prevented us from advertising as much as we wanted, but with the funds we had, we went extensively to television advertising and did very little radio and no newspaper advertising.

Television, we found, was far more effective in California than the other media. The radio spots consisted simply of using the audio portion of our television tapes. The radio spots were used strictly during the morning and evening commuting hours. California has a tremendous movement of people during these periods, by car. No money was spent on radio spots at any other times.

We were very fortunate in getting Mr. Walt Disney to serve on our Board of Directors. Mr. Disney produced a 14-minute color film depicting the need for more recreation facilities and lands in California. The film did not mention Proposition No. 1 by name, nor were there any political connotations connected with it. This film was paid for by the State of California, although Mr. Disney contributed most of it. The Disney Studios also did several television commercials for us which proved tremendously effective.

The Disney film was used with speakers and before groups that did not or could not enter into politics in any way. The film also was useful in campfire gatherings, State parks, and at camping facilities throughout the State.

Actress Janet Leigh, who is a member of the State Recreation Commission, was an effective booster for Proposition No. 1, and made numerous personal apperances in its behalf, as well as television commercials.

We asked Governor Brown's office to set up a luncheon at the Governor's mansion with the key radio and television people throughout the State. Using this technique, we were able to get many radio and television stations to go on record editorially favoring our bond proposal.

PRESSLIFT

Getting good publicity and newspaper coverage was very difficult toward the end of the campaign. Not only were the newspapers full of the Presidential campaign, the congressional elections and the State campaigns, but California also had 17 items to be voted on, on November 3rd. These included three bond issues and 14 other propositions. It was easy under these circumstances to get completely squeezed out of any publicity for your particular proposition.

We were able to obtain good press coverage at this critical time by establishing a presslift. About three weeks before election day, we obtained a private plane (which was donated to us) and formed a group headed by former Governor Knight and composed of Republican and Democratic State senators and representatives. For the next three days, we made nine stops and held press conferences around the State in support of Proposition No. 1. With this bi-partisan group, we were able to pick up coverage on every TV station and received no less than second or third-page coverage on every major newspaper.

All of the TV and press conferences were set up beforehand. The media people would meet us when we arrived at the various airfields and interview members of the group on the spot. The newspapers stressed the fact that both Republicans and Democrats were insupport of the bond issue. The main value of this technique was that Proposition No. 1 was in the newspapers and on television and being boosted by "name" people recognized by the public at a very critical point in the campaign.

Using this presslift technique, we were able to blanket the entire State and cover every large population center. We also held breakfast and luncheon news conferences, but they were more than just "news" conferences. We asked the reporters and cameramen to sit down and have breakfast or lunch with us. We received excellent coverage and the cost was approximately $2,000 for this three-day tour. Our organization could not have purchased this kind of publicity for $50,000.

The presslift and Mr. Disney's contributions were two of the cardinal assets in our campaign. We ended up with only five statewide groups in opposition.

PUBLICATIONS

Our publications consisted of two brochures. The first was a "slick" brochure mainly produced for the newspapers. We printed approximately 200,000 of these, which is a drop-in-the-bucket considering the 18 million voters in California. The other brochure was an inexpensive handout that included the 12 most frequently asked questions on Proposition No. 1 and their answers. Obviously, we created the questions and the answers. We printed close to ¾ of a million of this hand-out pamphlet.

In addition to these brochures, we used another technique. Mailing in California is very expensive and the postage alone would have cost us upwards of $300,000. To overcome this, we went to all of the incumbent and non-incumbent candidates running for State and congressional offices and asked them to endorse Proposition No. 1. Further, we asked them to include the endorsement of Proposition No. 1 in their political mail to constituents. Our organization offered to pay $40 toward their printing costs, as being that portion of their brochure that would be taken up by our message. This proved to be very successful. Many of the candidates said, "We will endorse the proposition and forget about the $40." When we received a printer's bill for $40 accompanied by a copy of the brochure, we paid it. This technique enabled us to perform a mailing we could never have done otherwise.

At the very end of the campaign, we produced postcards with a personal message printed on them and sent them to the various conservation clubs (such as the Sierra Club) that endorsed us. We asked the members of these clubs to take their Christmas card list, starting with southern California, because this is where we lost before, and address the post-card to their friends. The message, urging people to vote on Proposition No. 1, was already on each card. The club members would simply sign them, stamp, and mail them as a contribution to the campaign. We had over a million of these personal post-cards printed and over 600,000 were mailed. These "people-to-people" cards proved to be a great success and were made to order in this campaign.

To keep parks and the need for parks in the minds of the people during the campaign, we went to a major sugar manufacturing company in California and asked them if they would put pictures of the various State parks on their small sugar packages for restaurants. Pictures of Squaw Valley, Morrol Bay, etc., and other major recreation parks began to show up on the tiny packages in restaurants all over the State. Proposition No. 1 was again not mentioned.

We did not use bumper stickers. Everyone was using such bumper strips and there were so many of them that we felt they were not effective. Two major billboard companies donated the use of ten of their large boards. We had no other signs posted in the cities. Most all of the political candidates were using signs of various kinds and we decided that to try to compete with them was ridiculous; we simply couldn't afford it.

To give an idea of the traveling required in a campaign of this nature, I put over 40,000 miles on my personal car; over 10,000 miles on rental cars, and flew on one airline, alone, 22,000 miles. Total traveling, including a trip to the east coast to see congressmen, came pretty close to 80,000 miles in this one campaign year.

No polls were taken because we had no money for such surveys and no money to put into added advertising in the areas of weakness that a poll might have revealed. We worked in the blind throughout the campaign; we were never overconfident and pressed the campaign very hard from the day it started until election day. The million and a half vote victory shows we were really in the dark as to what the results were going to be. And I believe this is the way to conduct a campaign, just keep working and working hard.

DISCUSSION

DISCUSSION LEADER CALLISON: I am sure there are going to be some reactions and responses to that very stimulating narration of the California campaign as presented by Mr. Henry King and read by Keith Hay. I am thinking that Ed Meeman may want to react to some of those things. For example, what is more important in a campaign like that than the television medium, or the newspapers? And why do they pass over radio? Perhaps we have a radio man in the audience. Why do they pass that over in their scheduling of announcements and publicity?

I think you caught that they pulled these people in when they had press conferences and got as much coverage as was possible.

MR. MEEMAN: As I said before, certainly there is no question about the effectiveness of television coverage. I think, though, that the one thing that is not taken into consideration and a very essential one is an attractive presentation of scenes of the park. That is bound to be effective on television. But what is not effective on television is a speaker coming on at the time the people want to tune in on their entertainment program. The short political announcement is quite effective on TV.

Most arguments can be settled not by either/or but both/and. I think today political advertising in the newspapers is a neglected opportunity because no offense whatever is given to the reader to see a display ad. A lot of white space is important, with its message. That is quite welcome to the reader as he goes through his paper, and since the newspaper is a matter of record, there is no question about its effectiveness.

Certainly it is no business of an editor to try to sell advertising. In fact, in Scripps-Howard the separation of the two departments is almost fanatical. But nevertheless, since I have been asked, I do think from the psychology of it, that it is neglected. I certainly would use it as well as doing everything you can to get space in the news columns and writing a letter to the editor. Don't forget that. That is one thing, certainly before the campaign gets on, strictly speaking, you don't have a lot to promote a controversial campaign by writing a letter to the editor. But you certainly can, before the thing gets hot, write a letter about the importance of the state parks and the bond issues coming up.

And one thing we ought to give attention to is what was done in the poorer states. I know that only a few states can do it. I don't know of any other states but New York where they have had a successful campaign that can do anything like this. But certainly there have been successes. There was a fine success in Kentucky and I think by energy we can get a lot done with less money.

MR. GREGG: I just wanted to know that the quality of the package had a lot to do with the success of the bond issue and that is that this was another of these programs which took a broad view of the objective. The $150 million bond issue had money in it for the acquisition of state park areas and for the development of existing areas. It had money in it for small boat harbors. It had money in it for grants to cities and counties for open space acquisition and development and it was the kind of a package which permitted them to put together this broad spectrum of public support rather than fish and game people fighting alone for fish and game purposes.

CONSERVATION AND THE NATIONAL BROADCASTING INDUSTRY

JAY McMULLEN
Columbia Broadcasting System, New York City

Recently I asked a friend of mine whether he thought it would be presumptious of me to speak here on the subject of "Conservation and the National Broadcasting Industry." I explained that I do not claim to be an expert on the entire broadcasting industry—and I certainly am not a specialist in the areas of conservation and wildlife. My friend pondered this for a moment; then said "Well I think anyone who stands up before an audience is presumptious—so you might as well go all of the way." In any case, there is no turning back now.

For the past 20 years I have been a broadcast journalist working primarily for CBS in the documentory field. Documentories and public service programs, as you probably know, are the main network vehicles for presenting to the public issues of national importance. Conservation issues clearly are of national importance and network programs concerning some of these issues have been presented. But, if you believe that the networks should devote *more* time to an illumination of conservation issues—I wouldn't be a bit surprised. There are two problems:

First, network time available for documentory and public service programs is limited.

Second, competition for this time is severe. I am sure you realize that conservation as a subject must compete with many other subjects also of national importance and interest.

Who decides which amoung these competitive topics will be selected for presentation at any given time? The decisions usually rest with the network's public service or documentory producers. And who are these characters?

Well, we are not such a bad lot, really. For the most part, we are specialists in no particular field, except the field of broadcast journalism. Most of us are not assigned (as some newspaper reporters are) to work solely in one subject area, such as politics, medicine or conservation. We are journalistic generalists. We jump from one subject to another: from the moon to Vietnam to a bookie joint in Boston. These jumps, however, may be spaced by from six months to a year. It may take that long, for example, to assemble just one TV documentory.

How does a producer select a subject in the first place? There are no set rules, but since the subject will be presented on a network, it must be of national interest and importance. It should be timely. If it is to be presented on TV, visual possibilities must be considered.

Since the producer usually is not an expert in any particular field, he must rely to an extent on the judgement and help of persons who *are* specialists. If the specialists are not aroused by and articulate about issues in their own field, chances are that the producer will feel that the public will not be very excited by them either.

I hope I am an exception amoung producers when I tell you that in the past 15 years at CBS I can not recall a single instance in which a representative of a conservation group contacted me to suggest a story or a reportorial investigation that might lead to a story. My door is open.

Selecting a subject is, of course, only the first step in the process of presenting a program to the public. Once that selection is made, the producer is in trouble. If his subject deals with issues of national importance, it probably is complex and controversial. If he simplifies the complexity *too much*, the experts will accuse home of destortion and of horrible errors of omission. If he simplifies the complexity *too little*, dials all over the nation will begin turning to the staccato of westerns, the shrieks of hospital dramas and the grunts of wrestling matches.

In handling controversy, the producer must be fair and give each side an equal opportunity to state its views. But, statements of conflicting views—if that is all there is—may generate plenty of heat, but leave the public no more enlightened than it was in the first place.

If the program goes deeper (and I believe it should); if it investigates, marshalls facts and presents conclusions based on those facts—it is certain to be called by some "unobjective." The producer-reporter soon learns that in the minds of some people, objectivity is that which comes closest to what they already believe. In their minds the so called "responsible" and "objective" reporter may be the one who reports only what they want him to report.

For example, when I was preparing a documentory called "The Silent Spring of Rachael Carson," I received hundreds of letters, all exhorting me to be objective. These letters even told me exactly *how* to be objective. They said in effect: be on our side; blast the arguments of the other side.

After the program was broadcast, one group—apparently feeling that it's viewpoint had not carried the day—invited me to suggest ways in which it could better present its cause on television—and seemed surprised when I declined.

More recently I produced a report on the traffic in amphetamine pep pills. To illustrate the ease with which these pills could be purchased without a license or perscription, we set up a dummy company which bought more than one million of the pills from a number of legitimate manufacturers. The day after the broadcast, a CBS executive received a letter from an acquaintance—a drug manufacturer who wrote! "You told me CBS was going to hire an objective science reporter. Well, last night something terrible happened on your network."

I wish there was never just cause for complaint, but obviously some bad programs are produced and occasionally incompetent reporting does fill the air.

The reporter or producer who probes into controversial issues usually finds no shortage of advocates eager to carry a banner of contention; no shortage of opinion. The difficulty is in obtaining pertinent facts and then in obtaining an objective perspective of those facts.

Understandably, the advocates of a cause may recite or present in press releases just the facts that tend to prove *their* case. I recall that a government scientist once told me there was no evidence that such and such was true. That was a fact. But it turned out that there was no evidence, not because the evidence did not necessarily exist, but because no one had looked for it. That was a fact too—one which the scientist failed to mention.

Today, almost every issue of national importance touches, in some way, a government agency. In fact, the government agency may be the depository of most of the information pertinent to the issue. Usually these agencies are most cooperative. But considering the sensitivity of some issues, a government agency may be understandably wary of the reporter. Particularly if that agency is under fire. In such a case, the reporter may run into what I call the Public Relations Barrier. This barrier may prevent certain facts or differences of opinion within the agency from reaching the light of public scrutiny. A solid front is presented. For example, we were told for years in effect that anyone who critized the government's pesticide spraying programs was either misinformed or a crack pot. Government experts were trotted out to proclaim that all was well; no mistakes had been made. Their statements remained unmodified until evidence to the contrary was presented dramatically by a lady named Rachael Carson who opened fire with a book.

Those are some of our problems. We have an important job to do. The challenge is to do it better. At best, my presentation has been sketchy, but I hope it may have added to your perspective of our role.

In conclusion, I am sure you will be pleased to hear that CBS Reports is now preparing an hour documentary program concerning the scenic and recreational resources of America that are threatened in the name of progress. The program will range over a number of areas of controversy. Among them: the Indiana Dunes, the Grand Canyon, the Coast Redwoods of California, the proposed Consolidated Edison power project on the Hudson River.

Some of the people who will appear in the program include Supreme Court Justice, William O. Douglas; Secretary of the Interior, Stewart Udall; numerous conservation leaders; spokesmen for the lumber industry; campers; and local residents directly affected by the issues involved. That program will be broadcast within the next two or three months.

It has been a pleasure for me to be here today. Thank you very much.

DISCUSSION

DISCUSSION LEADER CALLISON: It has been a great pleasure, Jay McMullen, and a special privilege for us to hear you. I don't think, as Keith Hay said when he opened the program, we have direct and frequent enough communications from the people who are involved in the production end and the editorial end of the communications industries.

MR. JOHN BRAINERD (Springfield College, Massachusetts): I cannot refrain from taking this opportunity before Mr. McMullen is flooded by conservation requests to request a documentary on the condition of school grounds and the need for natural areas for education. Thank you.

MR. JIM KEEFE (Missouri): Mr. McMullen, I certainly enjoyed your talk. In the forthcoming documentary I hope you won't overlook the Ozark scenic national forests and the fight to save the Buffalo River in Arkansas and other wild areas.

MR. MCMULLEN: I did not mean to imply that I was doing this documentary, but I will certainly pass along this information to the producer who is.

DR. GRAHAM NETTING (Carnegie Museum, Pittsburgh, Pa.): I don't know that this is a subject for a documentary and in posing the question, I am giving it to any of the speakers on the panel. I will admit that any one of us can think of exceptions. But in forming our alliance to promote the natural beauty and conservation interest I would like to pose the question how can we convert Christianity to conservation?

DISCUSSION LEADER CALLISON: I don't know that any one here will feel prepared to answer it, but it is certainly one that we can all ponder. The question is, how can we convert Christianity to conservation?

I see we have no theologists of the modern variety on hand to tackle that question, Dr. Netting.

DR. J. J. SHOMON (Nature Center Division of the National Audubon Society): I just want to add this word of comment about the last question that was raised. I frankly feel that we in conservation should not be afraid to cross the bridge. In our own work at the Nature Center Division of the National Audubon Society we have been getting the people in the religious field. It is one of the broad publics we can enlist in our support of the conservation movement.

As an example, many, many churches now are buying land and setting up summer camps and they are looking for advice and help from conservation people on how to manage this land. This is one area where I think we should not be afraid to cross the bridge.

I think there has been a feeling expressed here this morning that there is a need for conservation people to seek cooperation. How do you get cooperation? One of the ways to get this is to seek it, not be afraid to go to the religious leaders, not be afraid to go the people in planning, in park and recreation.

We are riding a wonderful crest wave now of conservation and conservation information and I would like to urge all of you who are here in state and federal work and private work in conservation not to be afraid to go to the people in planning, to go to the people in the field of landscape architecture. These are people who can render this country and the conservation movement a great deal of wonderful aid. We in the Society, as just one little example, were called in by a religious group in Indiana to make a survey on 5000 acres of land bought by a religious group that is interested in setting up a model outdoor education center. This is only one example among many of what we can do if we are willing to take the step across the bridge.

MR. MICHAEL PUGON (Richmond, Va.): I am not exactly sure what the man's motive was in asking this question, but I would like to call to the attention of those here that the Soil Conservation Society of America has for a good many years promoted Conservation Sunday, particularly among the rural areas of the country and this is a very successful way of promoting conservation through Christianity. This has proven to be very popular with the ministers themselves. Every year there are sample sermons sent out. I think perhaps more of the ministers make up their own sermons than use the sample ones, but at least, they get some guidance if they need it.

And in each year in each state the rural minister of the year is selected primarily on the basis of how well he carried out the program of this Conservation Sunday. So I think a lot is being done through religious groups. Perhaps you would like to elaborate a little more on what you are talking about.

DR. NETTING: I am aware of what the SCS has done to promote soil conservation through religious groups and ministers. But I think there is probably less contact in conservation than in any other influential opinion-molding group in our society. I raise the point because I think we all need to recognize this lack. And as Joe Shomon has said, we need to do more to try to educate the ministers who are molding public opinion in their congregations.

MR. BILL VOIGHT (Harrisburg, Pa.): I want to get back to Mr. McMullen and possibly to Mr. Meeman in this matter of ideas. I was forcibly struck by the things that I saw and heard in the opening general session of this conference. I have been attending them off and on since about 1946. And I think perhaps there might be an idea for a newspaper series or for a television documentary on the things, the historical record, what are some of the key things that have led to our seeing within the last month the Vice President of the United States appearing for a major speech before an outdoor group and the President of the United States boldly sending to Congress a message on natural beauty. If anyone had suggested this ten years ago, somebody would have immediately started hunting for a strait jacket.

MISS SHIRLEY BRIGGS (Audubon Society, Central Atlantic States): Getting back to the point Dr. Netting raised, I wondered how many of you might have been aware of a meeting held at the University of Chicago last summer, a national meeting of the faculty of Christian Fellowship. This is an organization, a rather new one, I think, of college professors and theologians, who want to find out what the others are thinking in various fields, psychology, history, political science and so forth. And for the first time last summer they had a seminar on conservation.

This was a week-long program, and we hope that this seminar can continue in the manner in which the other groups have. The national meetings come at odd intervals, but each field tries to continue having meetings and publishes papers in the field. One of these times I think we will have a proceedings of that session available and Dr. Remkay was there and there were others, but I think if any of you are interested in the idea of trying to share ideas between theology and conservation, that you might be interested in getting in touch with this group. The offices have been set up at the National Council of Churches in New York City. I think they can give you information on it.

DISCUSSION LEADER CALLISON: Thank you very much, Shirley. I hope Dr. Netting is beginning to feel a little better about Christianity.

CONSERVATION, A USEFUL ADVERTISING TOOL

THOMAS G. WATSON
Vice President, N. W. Ayer and Son, Inc., Chicago, Illinois

What in the world is an advertising man doing talking about conservation as a tool of his trade here at a convention of wildlife and natural resources experts?

Are there two categories of specialists (advertising men and conservationists) more completely at opposite poles in their thinking? One deals, you may say, only in ever increasing amounts of consumption—while the other thinks only of how to conserve our resources.

Now these two opposing points of view have been oversimplified and generalized for purposes of this discussion. Let's together, in a few minutes of time, investigate this conflict in goals—to determine first whether there is real conflict and then second see how we might join forces to achieve greater results on behalf of conservation.

First off, I want to put aside any arguments about the techniques of advertising. There is only too much advertising when you are personally gaining no profit from it. So it behooves advertising to develop smarter, less irritating ways of speaking.

There is only too much advertising when it becomes too noisy, too oblivious to realities of living as you see them. So it behooves advertising to speak in realistic, sensible terms.

There is only too much advertising when it becomes a destructive force when in the use of its media it helps breed violence and irresponsibility. So it behooves advertising to propose constructive solutions to man's current needs.

Now is there a way to use advertising properly? Can those of us interested in conservation utilize the power of advertising, and is one doing so today? I think so.

Those of you familiar with the Saturday Review Annual Awards for advertising of outstanding merit are familiar with the fine work of the Weyerhaeuser Co., International Paper, American Telephone & Telegraph, Container Corporation, Caterpillar Tractor, United Air Lines, Pharmaceutical Industry Advertising Program, to name just a few.

The Valley Forge Freedom Foundation has selected Caterpillar Tractor, Electric Companies Advertising Program and other similar campaigns for its award to Industry Advertising programs working in behalf of a better America.

I could go on like this for quite some time. But I think my point is made clear. Industry has and will continue to use advertising appropriately to achieve public spirited goals. These are fine advertising programs, and fine companies, working hard to accomplish better things for a better America in accordance with their own *enlightened* self interest.

You will notice something in common about all these programs. They don't shout. They are not offensive. They are done in good taste. They are usually clear and concise in their meaning. They are well written. And above all, they sell an idea—as any effective advertising should. Do you as conservationists have any quarrel or conflict with the above six points? I think not. If the techniques are right, we should welcome the use of any tool to help us in the proper conservation of our natural resources.

We in our company are sure that businessmen in America, as perhaps never before, are more enlightened in their activities and more responsible in their actions from a broader gauged public point of view. Business leaders have taken leading roles in urban renewal, cultural development, water conservation, aid to schools and many other public spirited activities. They are anxious to take a proper role in public affairs. Let's avail ourselves of such opportunity.

And many businesses, and more will do so, are gearing their efforts, from an advertising point of view, to more public interest activities. So maybe advertising is not in conflict with conservation. Or stated perhaps a little better, advertising can be safely used for conservation goals. There is nothing inherent in it that makes it unusable, so quite rightly you are seeking ways and means to utilize it properly. If this is an accurate statement and with proper reservations you will agree with it what could you reasonably expect of advertising. Perhaps a case history in point will give us some clues. I am going to discuss one with which I am familiar because our company has developed it. But the Advertising Council has a number of fine programs some of you may be familiar with—Smoky the Bear, developed at no cost to the Conservation interest by Foote, Cone & Belding, and many other important campaigns.

For nine years since 1955, N. W. Ayer & Son has been preparing advertising for the Council for Financial Aid to Education, Inc. on a voluntary public service assignment, through the Advertising Council. The objective of the program, of course, is to increase the volume of voluntary contributions to the financial support of the nation's colleges. As the volunteer agency for Council for Financial Aid to Education, N. W. Ayer produces television and radio commercials and develops manuscripts and layouts for outdoor advertising, transportation posters and print advertising for consumer publications and business publications. The materials, for both broadcast and print media, are developed by Ayer and delivered to the Advertising Council, which handles distribution to the radio and TV stations, the outdoor plants and to newspapers and magazines, which in turn are asked to contribute the time and space to bring the public service messages to the public.

From the agency point of view, our work for the Council for Financial Aid to Education is handled much the same as for any other client, from client contact by the agency's service department, right through the development of print and broadcast advertising, except that all of Ayer's work for Council for Financial Aid to Education is done at no cost to the "client."

A new year-end report of the Council showed the following usage by the various media of Ayer-produced advertising for Council for Financial Aid to Education during the year 1964:

604 tear sheets from 398 newspapers
441 plates, electros and glossies ordered by magazines
2,313 outdoor posters (24-sheet) ordered for posting
61,329 car cards ordered for transit display
3,510 three-sheet posters ordered for showing
1,398,680,000 home impressions through TV commercials, and
26,743,620 home impressions through radio commercials

Use of the materials in the campaign for financial aid for higher education is a voluntary contribution of the media involved, at no cost to Council for Financial Aid to Education. Popularity of the campaign, "College is America's Best Friend. Support the College of Your Choice," is evidenced by the usage of materials developed by N. W. Ayer.

On the basis of the kind of a typical year indicated by the recap above, the Council estimated that public service advertising contributions made to the program over a four-year period, if reckoned in terms of the cost of broadcasting time, publication space and poster and car card displays, amounted to approximately $20,000,000. Projected to the nine years that Ayer has served Council for Financial Aid to Education as its volunteer agency, this would come to a total exposure valued at $50,000,000. Our program for 1964 has alone been evaluated at $19,000,000, so you can see our figures are on the modest side.

The Council for Financial Aid to Education conducts its own biennial surveys of the voluntary financial support contributed to the nation's colleges and universities, and the rise in the rate of these contributions has been spectacular. For the academic year 1954-55, which was the year before Ayer undertook the volunteer assignment to handle the Council for Financial Aid to Education advertising, the colleges reported a total of $289.5 million in gifts from all sources. For the 1962-63 school year, the total of all such contributions reported in the survey reached $1,139,200,000. Voluntary contributions, in nine years, have almost quadrupled.

Certainly, Ayer's public service advertising cannot alone take credit for this sharp rise in the total amount of gifts and grants to higher education. But college presidents agree that advertising has proved a major factor in their increasing fund-raising success. Ayer is proud to have had a part in this substantial growth of financial support to the nation's colleges and universities.

And, it's a good example, I'm sure you'll agree, of how realistic constructive advertising can initiate action toward the solution of a national problem. Short of complete National Advertising Council sponsorhip, many specific and highly professional programs can be worked out between responsible sponsors and the general advertising business. For instance, the program on water pollution in cooperation with the Federal Government. Its done an outstanding job in the past three years.

Now let's take a concrete example of the enlightened self interest of a company with whom we have been associated for over 35 years and see how it looks at a problem quite close to your hearts. The problem is one of water.

Mr. Blackie, President of Caterpillar, is vitally concerned with the conservation of our resources. He feels that Caterpillar's enlightened self interest starts with a belief that the equipment it builds plays a fundamental role in man's development. This is readily understood when you consider the worldwide needs of mankind in its search for better housing, better roads, better flood control, etc. No one business can focus on all these public needs. To do so could well require more money than is economically feasible. Also, to concentrate on all could well mean that none would receive proper attention. So five years ago, Caterpillar realistically made the decision to concentrate on bringing to the attention of the American public the need to better control and manage our water resources.

Man is not a conservationist by nature. You have to teach him to be—by education, by facts and by better understanding. If man is rational, facts and education can go far towards better understanding. Inherent within the proper understanding of a problem lies the seeds for solution. At least so we reasoned.

If we could more fully comprehend the simple truth—"When you disturb nature's balance in one area, you must compensate artificially in other areas to redress the imbalance." we are at the base roots of the problem. The words "compensate artificially" are key here. Water management, flood control, water development of all sorts, including perhaps the "by-product" of water for recreation all imply man controlling his environment better. To do this we must stimulate people, first to awareness then to action. Here advertising knowledge can be brought to play very effectively.

Are people aware of the serious water problem confronting them now and in the future? How aware are they?

These questions can be measured pretty accurately. At the low end of the scale, where there is no problem, there is little awareness. But let's look at a couple of examples at the other end of the scale.

In Effingham, Illinois, people became aware when 77 people in St. Aubrey Hospital were destroyed by fire. Why? Low water pressure. But 3 years later restaurants stopped serving water; residents flushed their toilets once a day; men shaved weekly to conserve water. The community finally pulled together and solved its problem—but only after serious dislocation of service and even death forced solutions.

Duncan, Oklahoma, had 70 serious floods in 20 years but at one point reserves of water were down to 1½ days supply. A reservoir mud flat forced awareness and solution followed.

Asheville, North Carolina, with 2½ feet of water in its reservoir lost over 25 new industries and suffered untold expense until awareness brought solutions.

These stories could go on and on. Where do water problems exist? Answer—almost everywhere.

The National Water Institute puts the blame squarely on the shoulders of the communities themselves. It points out that in towns of 25,000 and under:

One in five water utilities is deficient in supply
Two in 5 are deficient in transmission supply
One in three is deficient in pumping capacity
Two in five are deficient in treatment capacity
Three in five are deficient in distribution capacity.

And big cities are not without problems either. A year ago last fall in New York City reservoirs were at 30% capacity. Around Chicago where artesian wells flowed under their own pressure, new wells now go 2000 feet deep to reach the water table.

The U. S. Department of Commerce reports almost ½ of the municipal water suppliers in the U. S. are inadequate. Yet a careful investigation shows that we don't lack from total water. We suffer from the old problem of having it at the right time and in the right place. Correction yields not to generalized solutions but to awareness of individual problems leading to individual action, where needed.

Caterpillar's program points out this very action and its results.

Effingham, Illinois; Duncan, Oklahoma; Asheville, North Carolina to name a few communities have solved their problems of water shortages. Their problems and their solutions have been the very base for Caterpillar's advertising on the subject of water management. The program iself has dealt with the many phases of water control forthrightly, specifically and imaginatively.

Are people responsive to the message? Well how come 4,000 responsible citizens respond yearly to Caterpillar advertising on the subject by requesting the booklet Caterpillar has published—"Water Crisis U.S.A."? A recent survey indicates that awareness of water conservation problems within the audience of one publication we used increased in one year's time from less than 7% awareness to more than 22%. And awareness is invariably followed by action—where need is evident.

There is no magic panacea for water problems. But as responsible individuals we should keep these goals in sight:

1. We must conserve water on our forests and farmlands.
2. We must catch, and hold excess water in reserve, to level seasonal extremes.
3. Where needed, we must develop transportation systems to carry water from surplus areas to areas where it is in short supply.
4. We must stop polluting our streams, lakes and rivers—making billions of gallons of water unusable.

The water management problem has been solved in many communities . . . by informed, concerned individuals. It's a job for all of us. After all, if we don't solve it . . . who will?

So today I've said we have no real conflict between ourselves—Advertising and Conservationists. We have real need to work together. Advertising is a tool you haven't used to its maximum to help accomplish your goals. A quick evaluation of some current businesses and advertising thinking shows that we can accomplish much together, you and I. So why shouldn't we begin a realistic dialogue between ourselves leading to naturally needful and satisfactory solutions. It can't harm. It can help. I thank you.

DISCUSSION

DISCUSSION LEADER CALLISON: I know we are all very grateful to Mr. Watson for giving us this look into the inside workings of the mysterious and the ubiquitous, sometimes irritating and sometimes overpowering world of advertising. I think we all react to advertising; that is the purpose, of course, to make us react. We react in many ways, so I would not be surprised if we have more reactions now than we have time to hear.

MR. MIKE HUDOBA (Sports Afield Magazine): About a dozen years ago the editor of *Sport Afield* Magazine, who is present in the room, accepted an idea for an article called, "Big Business Bags Conservation," and the basis of that was merely the reproduction of the tear sheets of several of the national advertising campaigns of large companies. These were isolated, in instances, including prints showing the use of wildlife as illustrations for an advertising program. Subsequently there have been a number of very effective advertising programs we have had the privilege of serving in several instances, such as the Weyerhaeuser ads, the Sinclair Oil ads and so forth.

But I would like to comment that in the field of advertising there is probably one of the most effective combinations of natural resources available. This is the creative talent that is available in this industry and added to that is the extensive knowledge and understanding to motivation. We have now in the United States people who are deeply interested in resources—100 million visitors to the national forests—so here is a built in hunger of interest in the national resources, beauty and wildlife. And I am so happy to hear Mr. Watson's comment that there is a potential opportunity, a quite near probability of bringing these two interests together. I sincerely hope that all of those representing organizations who have made lifetime studies in the field of conservation, if we could get together and possibly even have a committee to bring this potentiality into a constructive reality.

DISCUSSION LEADER CALLISON: Thank you for a very good suggestion.

MR. ROGER HANSON (Colorado Wildlife Council): I apologize to Mr. Watson for the comment and question I am about to deliver. Of all the multitudinous bills in front of the Colorado legislature this year, the one that has vastly more attention than others and is creating vastly more controversy and has the whole state legislature up in arms with special investigations over payoffs, intimidation and bribery, is a bill to ban billboards along the interstate highway system of our state. This has become not a local issue, not a state issue, but a national issue. Even in the Vice President's charges to those things that are a desecration of our countryside, even he omitted to mention the billboard. Mr. Watson states there is no conflict between advertisers and conservationists.

As a former Chamber of Commerce manager and as a former advertising agency man, I think I know whereof I speak when I say there is a conflict and there has always been a conflict and a great chasm between advertising and conservation, and the main issue with the advertising industry and the national advertising associations of which I am a former member, has been over this issue.

In Colorado as elsewhere, advertising agencies, advertising associations, to a man, are with the billboard lobby and its continual fight over even any attempt to compromise on this type of legislation. Now if you really want to make a contribution, if you really want to provide leadership for the advertising industry, I think vastly more significant than free space, public service advertising, would be for the advertising industry in this country to stand up and be counted for perhaps the first time on this great issue.

DISCUSSION LEADER CALLISON: Thank you. I would have laid you odds, Mr. Watson, one to one, you would have received this challenge.

MR. WATSON: I am not standing here supporting billboards or the poster people, and I am quite willing to be quoted on this. There is a lunatic fringe in many businesses. None of us condones the lunatic fringe. The lunatic fringe in the billboard industry is lousy. I doubt if it will do much good, but if it will help some, I will say it.

I think there are a lot of bad things in advertising. I don't happen to condone white stallions running around cleaning my clothes I have worn in the steel mill. I don't care for 10-foot washing machines. However, I don't care for any washing machines. The idiot fringe of any business, and I really mean this, has serious questions thrown at it. They are private enterprises and I don't know how to lick them any more than I can stop the State Highway Department in New York from destroying my fish and my birds. But that is not an unfair comment.

What I am trying to point out is that there is conflict. If we are working together to try to solve some of these things, I think we do a little better job. I don't think we have worked together at all. If I am wrong, correct me, but I believe this is the first time we have even heard from the advertising industry in the form that you are putting it today. So I think I answered your question, and you can quote me. I think the lunatic fringe of the billboard industry is a lousy business. Again, I can't condone this type of activity in the billboard industry or, for that matter, in the advertising business or any other industry. But where we may have conflict is where we don't work together. I may find some things I don't care too wildly about that you are doing. You may find some things that you are not too wildly happy about that I am doing. But I don't think you are all bad and I don't think I am either. So maybe there is room for us to use one more skill.

The man in California has done it beautifully and I have never seen a better example of good thinking and good planning to accomplish an objective. I notice he probably didn't use billboards, because they are all used by the politicos. But there are ways of working together. That is my point here. I hope I have answered it somewhat.

[Applause]

DISCUSSION LEADER CALLISON: Thank you so much. I think you made your point very well.

MRS. RUTH SCOTT (National Council of State Garden Clubs, Central Atlantic Region): I am indeed back of the very thoughts there were just presented, but I have one suggestion to make, that the Advertising Council set up a very strong educational campaign to ban visual literature from our highways and our countrysides. There is no way that conservationists and visual literature can be together. This is something I think we must be very firm about and not use billboards to advertise saving state parks or natural areas or something of this sort either.

DISCUSSION LEADER CALLISON: That is a good point. That is the ultimate affront when the billboard industry thinks they can somehow pull the teeth of the mass of the public that presents these things by putting on their billboards on the highway, "Save Natural Beauty." I should not be surprised but what this happens.

NATURAL AREAS AS SCHOOL CONSERVATION EDUCATION AIDS

JOHN W. BRAINERD
Professor of Biology, Springfield College, Springfield, Massachusetts

It is apparent from the good words of the preceding speakers that the conscience of America demands that *all* the people be informed concerning our natural resources and ways in which they can be shared by *all* the people. Government agencies, mass media, and other private organizations are cooperating to educate in our democracy the people who make decisions affecting the resources of the democracy. That means all the people. Historically, a deep sense of responsibility growing out of the education for the privileged few has brought us irrevocably to the situation today where a vast system of public education along with private education tries to elevate every citizen to his or her highest possible level of understanding of himself and of his world. Thus every school administrator and every teacher worthy of the name is an idealist and an optimist working for a world where wisdom can create a greater society.

To some extent, every new-born baby has already *learned*, that is has received experiences from his environment which modify his behavior. His embryonic nervous system has begun to function bringing him messages and inciting reactions. Emerging from nine months of development bathed in a warm, dark, saline sea within his mother, he is ready to gasp air, alter his circulatory habits, wiggle his fingers, and seek for milk. Throughout life, this human will in many ways be milking his environment in order to stay alive. And the quality of his life will in large measure depend upon the quantity and quality of resources which he extracts from his environment. In our society today, instinct for survival is not enough. To get milk and bread and honey, one must also have knowledge. And in our society today, self-preservation requires a social approach to the problem of survival; milking the environment must be an enlightened *cooperative* action. That requires considerable schooling. What kind of schooling, though?

In this presentation, schooling means education supplied by schools. Such education should not preempt but should supplement what is learned at home, church, and elsewhere. Where other avenues of learning fall short, the schools must lead on. Today in fast urbanizing America, schools must apparently take over an increasing share of the job of educating people in self-awareness and environmental awareness. Millions of people have become product-preoccupied and resource-reckless. The school along with the home and the church has largely failed us. Avaricious instincts without adequate knowledge of social approaches to fast developing environmental problems are writing D I S A S T E R on the walls of humanity's nursery. We cannot grow up as a species—we cannot form any great society—until we are better schooled as to our relationship with our environment. . . . Schools must teach more ecology.

Fortunately an increasing number of school administrators now see the writing on the wall. Significant evidence is the latest Yearbook of the American Association of School Administrators. Entitled *Conservation—In The People's Hands,* it is a beautifully written plea for conservation by every community. But equally significant is the pathetic fact that the book fails to show adequately how administrators can help teachers present wise use of resources in the necessary multitude of ways. The authors and editors are to be congratulated for what they have done, the best job possible by people who have been trained in educational systems where ecology has not been adequately stressed. The book is strongly recommended for the widest possible use in communities across the land; but it leaves some major jobs undone. To one of these we address ourselves today, the use of relatively natural areas for teaching environmental awareness along with self-awareness.

The title for this address is "Natural Areas As School Conservation Education Aids." The basic problem, however, is the reverse, namely, "How can Man fit into the natural scheme of things?" rather than, "How can Nature somehow be added on to enrich Man's institutions?" We must realize that schools are newcomers compared to outdoor areas for Man's education. For a million years, Man was learning his place in Nature out-of-doors before schools were invented. While nobody would want to give up the school buildings which we have learned to make so marvelously in this latest moment of human history, we nevertheless must put them in better perspective and remind ourselves of what they really are. They constitute shelter from the elements for our pupils, our teachers, our books, maps, and other records; for our collections of objets d'art and scientific specimens; for our researching instruments and teaching tools. A school building should never be an end in itself. It is an aid to help us teach people about themselves and their relation to the world.

Unfortunately too many teachers live a life immersed in books or smothered in sophisticated instrumentation. They become very successful in writing books about books and in making new gadgets which transform life for multitudes. Certain pupils react enthusiastically to these modes of teaching and perpetuate them as socially acceptable forms of pedagogy. They provide scripts for entertainment on TV, new models of this and that which sell well, and drugs which lower the death rate. Innumerable children, however, genetically and/or environmentally different, are bored stiff by much of what is served them in our modern schools and would much rather go fishing. But somehow educators as a mass think it is wrong to go fishing during school hours. That typical attitude shows how far most educators have drifted from the major problem of education, the ecological relationship of Man to his environment.

Just think what a skilled teacher can do with pupils, a pond or stream, a fishline, hook, bait, and maybe a fish! Think of the challenging questions which he can ask to stimulate interest, broaden viewpoints, and indicate significant problems. Johnny, who are you to kill that little fish? But, Mary, suppose we never kill anything? What did *you* have for breakfast, Bob? What did the fish have for his breakfast? Where did the aquatic insects get their energy? How late in the day does enough light for algal photosynthesis angle into the water instead of just bouncing off? How does this time of day differ in Alaska north of the Arctic Circle at this season? Does the Eskimo kill fish? Is it right for him to kill fish? How does radioactive fallout in Alaska compare to fallout around here? Why do people pollute rivers of air? Suppose we put a lot of calcium chloride on the school tennis courts just behind this bank? And so it goes. A skilled teacher ought to be able to find enough of interest to his class to make them want to spend hours of research with books, maps, and laboratory instruments back in the school building. Of course Louis Agassiz could do that with a pickled fish set before his college students; and today many a fine biology teacher can reveal to certain students a preserved frog as a glimmering miracle rather than a gutsy mess. But too many teachers see only the parts of the specimen as isolated parts to be named and memorized. Too few see the ineffable machine-of-a-frog which transcends any machine; too few see the frog as an integral part of an aquatic community; too few see the brook or lake as a part of a biome which Man invades with a metallurgicochemical culture capable of changing it utterly. And they cannot show to their students what they do not themselves see even dimly in their mind's eye. The pickled frog does not seem to relate to the child, who therefore complains of the smell on his hands at lunch and who, if he has enough spunk to rebel against his teachers, parents, and other social pressures, may well become a school dropout.

A relatively natural area is a necessity for modern urban and suburban education. An aquarium is a step in the right direction. Some teachers use one very effectively for ecosystem instruction. A well-kept aquarium is a relatively natural microcosm compared to a specimen jar with formaldehyde which prevents fungi from cycling nitrogen. Similary a window box is a minature natural area which can raise a lot of questions which would not normally arise from a pressed specimen in a fumigated cabinet. But how much educational hay can a teacher harvest from a field the size of a window box? Not enough in these days when children are starving for contact with nature, intellectually and spiritually starving. The aquarium and the window box do not have enough cubic capacity to produce the required amount of education. And sadly enough most teachers cannot begin to use even these tiny relatively natural areas because they themselves are now too far from nature to appreciate them. For instance, how many English teachers can harvest good themes out of an aquarium? Pathetically few. It is not enough to have biology teachers giving natural resource instruction. Every teacher in the school should be doing it as a part of his or her subject or grade level. Every teacher should be able to use an aquarium.

But what our schools so desperately need is relatively natural areas, on the school grounds or nearby. Even a city courtyard, paving-floored and brick-sided, is more natural than a classroom; it has a sky instead of a ceiling and that can make a world of difference for the skilled teacher. It gives a natural opening for such subjects as astronomy and meteorology and the physics of light. It leads to the sociology of soot and the seriousness of smog. It can introduce a young poet to the forms of clouds and a young artist to the contours of a pigeon's wing. But the paved court has serious limitations, of course, even though few schools now use their courts to those limits.

A few shrubs planted at the foundation make the school environment a bit more natural. Buds during the winter tell of nature resting according to plan, and when they begin to open they speak of functioning xylem and phloem far more eloquently than any text book can. Just one bush can enable a skilled teacher to take that important step from text-teaching to touch-teaching, thereby putting the children in closer contact with the natural world which makes their lives possible. Greater awareness—greater appreciation.

Lawn! A mid-city school may be fortunate enough to have a little patch of lawn. It can help the youngsters visualize the King Ranch in Texas, if the teacher is effective. A probing pencil can investigate soil compaction; scissors can help measure productivity in clip-quadrats; a dog does his after-dinner duty and nitrogen darkens the grass. Good audiovisual aids in the classroom can help explain the lawn—but they cannot take the place of a real, live lawn!

Now consider the typical new suburban school at Smithville, where lawn has been recognized as a good thing for stabilizing soil, for letting the eye run, for giving a nice odor when the grass is cut. It also enables water to soak in, to permit people to admire the new school building, and to give employment to people who cut it. It makes money for the people who first make it and for people who sell mowers and gasoline. Besides, Jonesville, next door, has a new school with lots of lawn. So style-conscious and nature-nescient, Smithville goes lawn-loony. To make lawn and more lawn, a marsh is drained, a brook is buried in a culvert, a hill is bulldozed into a swamp, a woods is cut down, a brushland is cleared, and a field of goldenrod (with milkweed at the lower edge) is obliterated. Lawn! A real, live lawn! For variety, there is a paved parking lot. But just think what skilled teachers could have done with the brook, the marsh, the swamp, the hill, the woods, the brushland, and the bee pasture. Natural areas like those make an aquarium and a window box look a bit inadequate, don't they?

. . . .

It is happening every day, literally. Natural resources needed for nature study are being destroyed daily by nature-ignorant people who thus escalate nature ignorance. You know it. Destruction is most prevalent at the urban fringe, the lunatic fringe. But near the center of cities the last brooks are being crammed into concrete and the parks are being turned into parking. In the rural villages, schools are being confined more and more by development. Regional schools are making rural campuses look like suburban golf courses, only with less variety. You have seen it yourselves. I am not trying to tell you what you do not know. I am just trying to make you mad. Personally, I am furious.

Open anger only irritates. What we need is a few thousand conservationists with exterior calm and an internal, driving, ulcerous anger that gives no rest until we have taken significant steps to defend our first line of natural resource defense—the schools. And among those few thousands of indignant conservationists, we should be able to count each one of you.

What sense is there in protecting bears when ignorant people in the parks treat them like lap dogs? Why sell fishing gear to city boors who break bottles in streams where country children wade? Is it reasonable to set aside natural areas when one bored schoolchild is so apt to set a match to it on a southwest day in October? Why build more and more highways to move more and more people when what the world really needs is population control other than war? Why try to increase the gross national product while trash disposal is becoming an increasingly horrifying problem? Do soda crackers have to come with three or four protective layers? Do today's children have to be so sealed off from fresh air and dampness that when they grow up they go shoot cows instead of deer? . . . . It isn't funny. Our schools are leading the way in natural resource destruction. They are setting the worst possible example to the impressionable young in their charge. While they should be inculcating the irreplaceable values of natural resources, they are destroying them on their own sites. There is no sense to it.

So what do we do? Here are some suggestions. As in all first aid, we must collect ourselves. Then we brush down the hackles at the back of the neck and go get a glass of milk for our ulcer. Then we look around. We size up the local situation, visit a few schools, get some data, take our slide camera along or a camera-toting friend. We get pictures of schools with natural areas which are being used, schools with natural areas which are not being used, schools with natural areas which are being lost; schools without natural areas—some without even a window box.

Next we have the choice of either going directly to the superintendent of schools, or to a principal of a school, a teacher, or lay groups such as sportsmen's clubs and garden clubs. If the superintendent is approachable and interested, the most progress can usually be made fastest by going directly to him, expressing our concern briefly, and asking for his cooperation in improving school land use for natural resource education. He may be approachable and interested yet very poorly informed, because of our past mistakes in training school administrators. We must not put him on the defensive. We should let him know that we realize that he will need help and try to show him how it can be given by government extension services, private consultants, and interested laymen. We ask for an opportunity to show our pictures of local school land-use to teachers and administrators in his school system so that we can exchange ideas with them about maintaining or increasing the variety of school environments useful for education.

When you meet school people, try to get *from them* ideas as to how they can improve their schools; in the process you can certainly give them your ideas. Realize that schools are beleaguered by all sorts of people telling them what to do. For instance, if you ask for a special workshop on outdoor education for the teachers, you will be reminded that in the past month the superintendent has received requests for a workshop in remedial reading, modern math, and non-representational art. But don't back down; school systems must be helped to decide what is most important; they must be shown that ecological awareness *must* be taught if the human race is to survive. (More detailed suggestions for approaching schools are given in the paper entitled "Helping Schools Study Wildlife" in the *Transactions of the Twenty-fourth North American Wildlife Conference*, 1959, pages 524-530, which also include notes on mapping school grounds, taking inventory of wildlife, and other practices for wildlife management by the pupils.)

If school officials seem to feel that they are already doing the best possible job of managing their school grounds for education and that they need no help from us, then you must really get to work. You will need lots of help of many different kinds, so solicit it from different kinds of people. Here are some possibilities; consider carefully which can be most helpful in your community.

1. *School administrators.* Don't rule them out just because your first move seemed non-productive. Ask the superintendent to recommend a principal of a school who might be interested in having his teachers and/or students see your slides of school grounds. Then ask this principal to name a teacher who might like to have his or her class do a schoolgrounds project related to what is currently being taught. An entree to one school is a big help.

2. *School teachers.* Ask around to find one or more teachers interested in the out-of-doors, perhaps one who has been to an Audubon workshop or who has worked with Scouts or who likes to hunt or fish. Approach this person at home and see if he or she would be interested in a schoolgrounds project, as noted above. If so, help work out a project (and then make sure that it has the principal's approval).

3. *Children.* You need energy, enthusiasm, time and keen senses; kids have all of these assets so be sure to rope them in. Occasionally it is possible these days to deal with kids who are not in organized groups with grownups telling them what to do every time they turn around. These kids may be the most helpful, so hunt them down. Get these youngsters making maps of the town and recording the various environments, including, of course, the relatively natural ones. They can perhaps take pictures too, and write notes about their favorite haunts, which are often the thickety, muddy ones worst for parental supervision and best for wildlife. When these kids are really rolling, suggest that what they are doing can perhaps be related to their school work. First thing you know you may have hooked a teacher, who may be bait for a principal—and the superintendent may even swallow the whole affair and help introduce a townwide program of natural areas for schools.

4. *Youth Leaders* in organizations such as Scouts, 4-H, Boys Club, Campfire Girls, and Future Farmers of America. Inventory of relatively natural areas makes an excellent project for a youth group. Show them how to use topographic maps, aerial photos, and other surveys. Get them to make some sort of show of what they learn, perhaps a window display in a bank.

5. *Women's Groups* such as women's clubs, garden clubs, and the League of Women Voters. These people can do such great things, especially politicking, that it is worth it to have the men come home occasionally and find that supper isn't ready. Dedicated women have time and again saved the day for natural resources. Be sure to ask their help in setting aside relatively natural areas for schools.

6. *Men's groups and mixed groups.* Sportsmen's groups have often led the way in preserving wildlands. Occasionally a Junior Chamber of Commerce or other service club has given a real lift to community conservation. Conservation groups such as Audubon can be a tremendous help. They may already be busy; but there is nothing like a new project to draw in new members and expand the good work. The problem is always leadership. Look for it diligently.

7. *Photographers.* Picture-takers are sometimes worth a thousand word-writers. Photographers always seem to have time and money and a discerning eye. You need them. Get them taking pictures of

nature subjects found in relatively natural areas. Have them give slide-showings for various groups in the community, including the schools. Have them display salon prints in store windows with labels indicating which natural area was the source of the subject. (The American Nature Study Society is experimenting with Community Slide-showings to promote nature study and to procure audio-visual aids for the local schools. Write the author of this paper if you wish information on this subject.)

8. *Newspaper, radio, and television people.* These good people want news. Natural areas are full of news, but it needs to be interpreted so that newsmen can see it. If you take the trouble to prepare some interesting facts about a natural area, the newsmen will often use it. You are helping them. And if your community is to make a decision whether to save a school natural area or have a new housing development, you will be very glad to have some of the press and radio people on the side of natural areas. If you yourself are not adept at writing or do not have the time, try to find somebody with a flair for nature and writing who can feed material to the mass media.

Out of all this endeavor will emerge some salient facts. Certain relatively natural areas in your community are inestimably valuable for natural resource education. These areas should be listed, described, and assigned priorities for preservation. Then they must be preserved for school use, by any legal means possible.

If our communities continue to fail to recognize the need for relatively natural areas for outdoor education and if we fail to preserve such areas for instruction, the greatness which our society already has will surely dwindle. It is not just the pioneer spirit and hard work of people coming from many lands which has made our country great; it is largely our natural resources. Failing to appreciate them, we destroy them. Destroying them we destroy ourselves. Attenders at this great conference know full well the dependence of each one of us on our natural world, no matter how artificial our immediate surroundings. We know where our milk comes from. But there are increasing millions who don't. If they cannot be raised to a higher level of ecological understanding, social disaster is inevitable. To achieve the better education which the times demand, we must have natural areas for conservation education at schools. To have these areas, we must go get them now!

DISCUSSION

DISCUSSION LEADER CALLISON: Dr. Brainerd is a very effective advocate and I know he is a very skilled teacher.

I would like at this time to present to you and for the record of the conference this morning, a brief statement that was written out by a New York teacher who found herself at the last moment unable to attend this session. She felt so keenly about it she wrote out the comments she wanted to make or the suggestion she wanted to give to this group today. I will read part of it and it will be included in the proceedings.

[Mr. Callison read the folowing statement sent in by Miss Harriet Gillilan.]

As a science teacher of grades 1-8, I am encouraged by the children's receptiveness to new ideas, especially constructive ones. I am also delighted with their interest in the natural world. To say that there is very little interpretive teaching done with the "living natural world" is alas very true.

Now, as our national parks are becoming used more and more, as they should be, and as the grade school children of today will be the parents of tomorrow, it is definitely time to instruct these children. Of course, to continue to advise the general public is still imperative. However, if a booklet in a form that the children would readily accept and be influenced by, could be given throughout the elementary schools—at one grade level to be decided on—the proper ideas as to the use of our parks, plus the value of their treasures, could be at least started.

I have used a "cartoon" booklet, put out by International Paper Co. It is distributed in the public schools, especially in the south where the rapid reforestation for paper pulp is so important. There are several other books on other phases of the paper industry, with a teacher's manual for each different subject. The children "go for" these immediately.

Now, the character of Smoky the Bear is copyrighted by some group in public service. So we will assume hopefully that he would be available as the lead character. I have written up several ideas for Smoky's instructions if anyone would care to have them and would be delighted to send them on.

In my classes in New York we use this idea with slides (instead of cartoon books) about Central Park. We learn that even if we were the richest person in the world, we couldn't have a place as beautiful as Central Park. It is *ours* not only to enjoy but to take care of. We don't want anyone abusing our splendid park. We pick up any trash we find while walking there. We enjoy and learn about the trees and shrubs and learn what birds and mammals can live there. A student shows the slides of the park at all seasons—what birds to expect at what seasons—learn about squirrels, their food gathering, semi-hibernation, etc. I feel certain that these young will be guardians of the park not only now but always.

As 100,000 *informed* people can use a national park and not damage it—1,000 destructive people can do great harm. Smoky is an appealing character, a constructive character, already firmly implanted in many children's minds. Therefore his great value. If it is too costly to give them out in schools, they could be given out to the children at the park entrances. I truly believe that Smoky's message could be so convincing that the books would *not* be found around as litter.

Might this not be tried at least at one park?

Harriet Gillilan
1239 Madison Ave., Apt. 3C
New York 28, N. Y.

DR. J. J. SHOMON: I can't let this opportunity pass without commenting on the very fine thought that John Brainerd has given us. Unfortunately, he didn't have time to go into any details as to how you convince the school administrators. And I am sure that when he speaks of schools he is speaking in the broad context, including colleges and universities.

But you might be interested to know that there has been some headway made for people like yourselves, guidelines prepared as to how to go about helping to create natural areas for schools. I am thinking of the article that appeared in the December issue of the New York State *Conservationist*, which was specifically prepared for this kind of purpose. How do conservation people help school people and how do they convince school people of the importance and the necessity of the natural areas? If you cannot get the magazine itself, they are going to reprint 100,000 copies of that issue, and I would urge that every one of you get a copy of it. There is a plan there that is quite practical and probably would be useful in many parts of the country.

DISCUSSION LEADER CALLISON: Joe, Mr. Meeman wanted to know what the address is. How can they write for it?

DR. SHOMON: Write to the Editor, New York State *Conservationist,* Albany, N. Y., and refer to that article on natural areas for schools.

TO EACH HIS OWN—TAILORING INFORMATION PROGRAMS TO FIT THE AUDIENCE

DICK H. SCHAFFER
President, American Association for Conservation Information, Lincoln, Nebraska

"I continually have at my finger tips resource management facts which cannot be put into effective use because the public is not ready to accept them."

Possibly some of you recognize the voice as that of M. O. Steen, director of the Nebraska Game, Forestation and Park Commission. But the voice at this time is unimportant. Of prime importance is the message, and this most of you recognize. The situation described, calling for communication and education in order that facts developed by science may put to use, is common to most fish and game agencies in the United States and Canada. You, as scientists and managers of our natural resources, have a job to do, and the tools and know-how to get the job done. And we, as communicators in the information and education field, have to prime the public at large to understand and accept your programs.

Illustrations of problems and lack of public understanding and acceptance are many. Let me use Nebraska as an example. I do this only because I am more familiar with it than any of the other states. There are some people who still take exception to the way the Game Commission is managing the ring-necked pheasant. Nebraska is attempting to get better utilization of pheasant resources, and particularly the cock. Between 35 to 40 per cent of the surplus roosters are wasted each fall despite long seasons and liberal limits. The primary reason there is such a surplus is because the hunter is unable to catch up with the rooster.

Another common example is fish stocking. In Nebraska only a small percentage of the harvestable game fish in the state is being harvested, yet there is a constant human cry for more hatcheries and more stocking. The angler is convinced that if he doesn't catch fish it's because there are no fish. No other reason for his empty creel enters his mind. Yet the facts are that only about 15 per cent of the state's harvestable game fish are being taken by hook and line. Except for new waters and corrective stocking, the continuing stocking of fish is a complete and colossal waste of public funds.

Communicating with the public in Nebraska so that it realizes such fallacies as these is the role of the Game Commission's Information Division. We are continually striving to achieve an understanding of management and its techniques with the general public. Other fish and game agencies in the United States and Canada generally are faced with similar problems, and they, too, have initiated information and education programs to open the door for the technician's proved management concepts.

The manner in which the different agencies achieve, or attempt to achieve this understanding through their respective I&E programs runs the gamut of communications media. Radio, television, newspapers, publications, movies, and personal contact are all brought into play. Even within each communications medium there is a full repertoire of approaches and techniques. Some agencies employ strictly informational approaches while others resort to education. And the degree to which each agency employs these different approaches varies considerably. The media and approach which would best do a particular communications job for one agency might do just the opposite in another state or province. Each agency has to more or less tailor its approach based on the problem, objective, the audience, and the means and manpower available.

Let's take a look at some of the communications media and how some of the different agencies employ varying techniques. First the field of radio. Most of the fish and game agencies are active in this voice medium, with the majority of the departments originating their respective programs. The frequency of programs is probably the biggest variance, depending much on each agency's facilities, manpower, and moneypower.

In Missouri, two approaches in radio are employed. The first involves the conservation officer. Each is trained in radio presentation and regularly receives program material from the department home office. In this presentation, the programs have a local flavor, with the local officer delivering the message.

Missouri's second approach involves a program tailored for a specific message for a specific audience. One of Missouri's greatest conservation problems is forest-fire control. It occurred to some members of the Missouri staff that if professional entertainers could sell soap and other commercial products through song, then why couldn't fire prevention be sold in much the same manner. Accordingly, a new radio series was born, along with "Woody, the Singing

Forester." It is geared to entertain and reach the people in rural and backwoods areas. These folks are responsible for most of the forest fires. While entertaining, the program does a hard-sell job of forest fire prevention.

According to Missouri officials, there is no way of measuring the value of such a program, but it has high public appeal as well as being popular with many radio stations.

Some agencies employ strictly interview-type programs, where a member of the I&E staff chats with other members of the department or outside conservation and related professionals. Another approach is the taping of an actual hunting or fishing experience where the message is delivered indirectly and in an entertaining way. Still other agencies resort to direct telephone-to-radio station reports. The timely report can, if you wish, direct fishermen to hot spots, while they're hot. The big value of such a direct radio report is that it can be carried moments later over the air.

Next up is the field of publications, with emphasis on the so-called conservation magazines. There are no two magazines alike, with the type of book, format, content, presentation, and distribution running the complete gamut. These range from typewritten, multilithed eight-pagers to four-color slick jobs that hold their own on the national market. The type of book published by the different fish and game agencies depends on the objective; selected approach; financial capacity; subject matter; type of distribution, free or paid; and available talent—editorial, illustrators, and photographers. Any magazine can only be as good as its content and the people who put it together. You select any type of magazine and you'll be likely to find it in the fish and game field.

The *Nevada Wildlife* is an example of a minimum-cost publication. Copy is typewritten. This monthly publication possibly was multilithed by department personnel and equipment. Distribution is free.

Here is the seasonal, quarterly *Delaware Conservationist*, a free 6 x 9-inch, 16 pager, simply done, and everything in this particular issue, of a technical nature. Two colors are used on front and back covers and on some inside pages. Quite a few of the magazines published by the different agencies are 6 x 9.

Iowa's Conservationist is a non-stapled tabloid-like publication. According to staff members, it is designed to convey and sell the philosophy, work and policies of the organization to the people of Iowa. The Iowa Commission wants the publication to be crammed full of material and thereby maintain its reputation as a bargain periodical. The rate for this monthly is $1 for two years. The tabloid format has been retained because it is economical to compose and print. Color is not used because of the feeling that it would not add enough to the appearance of the publication to warrant the additional expense.

Possibly boasting the largest circulation is the *Missouri Conservationist*. Now dressed in a four-color cover, this monthly is considered by Missouri staff members as one of the state's sales pieces. It is just as important a part of the Missouri program as is the biologist who lays out a farm pond or recommends habitat plantings. The magazine is free for the writing, and Missouri has no plans to charge for subscriptions. The feeling in Missouri is to continue free distribution inasmuch as those people who are willing to buy subscriptions are for the most part already sold on the department and its program. Missouri is attempting to reach those persons who are not yet acquainted with or sold on the Conservation Commission and its program. The latest monthly printing hit 163,000 copies. Unit price was only 4.3 cents.

Here is a magazine that has high subscription and single copy rates, accepts advertising, and is sold on newsstands in much of the country. Receipts in 1964 totaled almost $100,000. While the magazine receipts are tremendous in fish and game agency standards, they still fall short of actual printing costs. It is not the intention of the Nebraska Game Commission to have the book pay its way. However, receipts from subscription and single copy sales along with advertising permit the department to do a much better job of presenting the Game Commission and all of Nebraska to its readers.

Outdoor Nebraskaland is the show place of Nebraska and the Game Commission. It is unique among the various fish and game agency periodicals, for it runs the gamut of outdoor recreation and vacation opportunities. The introduction of 14 pages of color and a more aggressive promotion program contributed to a 34,500 book increase in printing in one year. It has created a new image of the state and has become the foundation of an aggressive management and tourist program.

Each agency has its own method of reporting its activities after each year or biennium. These reports range from inexpensive multilithed publications to expensive four-color magazines.

Some agencies prefer the small 6 x 9-incher, such as this one from Utah, while others lean toward the bigger 8½ by 11-inch format. Presentation, though, is another matter entirely. New York in its Conservation Highlights tells its story in short simple paragraphs, uses lots of white space, and illustrates each page with line drawings. The entire report is only 34 pages. On the other hand, Michigan goes to the inexpensive multilith process and merely combines the annual reports produced by its different divisions. This bulky publication is stapled together, front to back, rather than saddle stitched.

Maine, as do many other states, turns one issue of its magazine over to its annual report, including the report material with regular magazine articles. In such cases, the report is highly condensed and is written somewhat in story form. One possible advantage to this type of presentation is that the report will reach more people by being included in the magazine. Some readers, however, might feel short-changed if the presentation is not handled well.

Another commercially printed report comes from West Virginia. Unlike Maine, this state devotes one entire issue of its magazine to the annual report. This 6 x 9-inch publication takes 94 pages to tell its story.

While preferring the lower cost of multilithing, Idaho take a little different approach to binding. The 106-page offering is encased in sturdy covers and spiral bound.

Last is Nebraska's annual report, possibly the least expensive of all. The report is considerably condensed and is multilithed. State law requires the printing of an annual report, and this meets those requirements. There is very little public demand for the report, and the Game Commission feels money saved on this publication can be spent more effectively elsewhere.

Hunting and fishing regulations are as different from one another as are the individual agencies that produce them. Here the number to be printed, extent of information to be included, and money available determine the type of production. The regulations run the gamut from elaborate full-color maps to modest little sheets folded in half such as this one from Idaho.

California sport fishing regulations are more complicated than in many states and vary from stream to stream. Each water area and its limits and regulations are outlined in an inexpensive 32-page pamphlet printed on the lowest-cost pulp paper. It may be inexpensive but it covers the material and gets the information out to fishermen.

Colorado goes to a more elaborate style. Printed in two colors, this state's fishing information is included in a 44-page map-size booklet, which is centered with a full, four-color insert.

Arizona on the other hand, keeps it simple with a handy three-fold single-sheet format which fits easily into the angler's pocket. Tennessee in its hunting guide also uses the handy pocket-size format. It includes sunrise-set tables and a listing of conservation officers in addition to the regulations.

West Virginia goes all out with its full-size and full-color map of hunting areas.

News packages from the various states and Canadian provinces vary, but not nearly so greatly as other phases of information programs. Some agencies prefer to send only special releases, when warranted, while others stick with the regular weekly, bi-weekly, or monthly packets.

The main thing that sets this group apart, which includes Wyoming, Arizona, and Kansas, is that their packets are self mailers, saving the costs of envelopes and stuffing.

This self-mailer from Arizona varies the color of its cover from week to week. Inside the format is much the same as that of most other states.

Our next two slides show the variety in headings, paper selections, and style from state to state. Ontario likes the white paper with a deep green heading. Colorado and Missouri, on the other hand, both go to colored paper. Missouri uses green ink on light green paper, while Colorado goes to black ink on a darker green paper. All three list their contents at the top of the first page, and then go on with their first story on the same page.

In our last grouping of three, we have still another contrast. Idaho uses no contents listing at all and sends a group of stories as a unit, but still all separate. Pennsylvania is typical of the states who still prefer the long, legal-size paper. Here, too, there is no contents listing. The Nebraska Wildlife Notes devote the entire first page to a standard heading and table of contents. As you can see, ideas overlap here and there. Each state has its own ideas and these are manifested in the types of news packages they produce.

A number of fish and game agencies are using television and its vast audience to do a big share of their communicating. Some agencies produce television shows on a regular frequency basis. Others merely provide personalities and film at irregular intervals.

In Oklahoma, the thinking is that there is no good media available which can reach the general public with a volume of feature material as effectively and economically as television. Oklahoma likes television because of its ability to involve the viewer in an emotional experience that makes him feel and be a part of the subject rather than an observer. With television, the factors that allow this emotional experience are sight, sound, movement, color, mood music, and on down the line.

South Dakota used television effectively to tell its annual report story. A filmed report 26 minutes long and costing about $800 was made. This was used as a TV show to acquaint the public with its operation and also was shown to the legislature to acquaint the members with the department's activities and accomplishments. According to South Dakota, many legislators had a printed report a month before they were shown the filmed annual report, but only a few had even glanced at the printed copies.

Time prohibits further illustrations, but continuing on would not affect the conclusion. The various agencies tailor their communications to the media and technicians that do the job for their particular situations. And to get the best job done, the Information divisions of most agencies are striving to improve their efforts in communicating with the public. As members of the American Association for Conservation Information, they have called upon the top professionals in the communications field to aid them in their endeavors. They do this in several ways. The AACI sponsors several short courses in various media. Here communications personnel attend "quickie sessions" to visit with and be critiqued by top communications specialists.

The organization's awards program also plays a key role upgrading agency efforts. Each state is asked to participate in competition annually, submitting entries in eight different communications categories. The entries are forwarded to outstanding people in the communications field who judge each agency's effort and select those who have done the very best job for the preceding year. Each entry is judged on its ability to fulfill its stated purpose, based on the highest professional standards of that particular medium.
The results of this continuing awards program become more evident with each year. Individual agencies have an opportunity to evaluate the critiques given them and strive the next year to take the suggestions and employ them in an improved effort.

Though the AACI and its members are pleased with the results of this project, they realize that even more must be done if they are to get the job done. Communications is a science, too, but one that is ever changing. New trends and new media are continuing to become available. Each has its place in selling management. AACI and its members will continue to keep abreast of these changes, utilizing them to the fullest degree in selling resource management to the general public, a public that is becoming more outdoor oriented with every passing day.

DISCUSSION

DISCUSSION LEADER CALLISON: Thank you, Dick Schaffer. I think that was an excellent presentation. It brings us back to the realities of our own jobs.

I will turn the meeting back to our chairman.

CHAIRMAN HAY: Thank you, Charlie. Needless to say I think all of the papers were of the highest quality, and I want to personally thank every individual who participated in this for their help and the effort that they took to come down and present these fine papers. I think we pointed out a lot of things where the conservationists may be going amiss; some of the things we are doing well and some of the things we are doing badly.

A NEW CONSERVATION FOR AN URBAN AMERICA

An Appraisal of the 30th North American Wildlife and Natural Resources Conference

MAURICE K. GODDARD[1]
Secretary of Forests and Waters, Commonwealth of Pennsylvania, Harrisburg

The President said it in his Conservation Message on February 8:

"The same society which receives the rewards of technology must, as a cooperating whole, take responsibility for control. . . . To deal with these problems will require a new conservation. . . . Our conservation must not be just the classic conservation of protection and development, but a creative conservation of restoration and innovation. Its concern is not with nature alone, but the total relation between man and the world around him."

The Vice President said it at the opening of this conference:

"We seek now a new conservation—one of people as well as land and resources, one of metropolitan areas as well as of open country."

Ira Gabrielson, the President of the Wildlife Management Institute, said it again in the first speech of this meeting when he called for an "ecological conscience."

Ernest Brooks, President of the Old Dominion Foundation, repeated the same thesis:

"Conservation is an idea whose time has come! . . . It is obvious that man has fulfilled the ancient directive to 'be fruitful and multiply and replenish the earth and subdue it'. Now he must learn to understand the ecological consequences of his conquest."

Senator Kuchel, of California, echoed the theme later that same morning:

"For perhaps too long, conservationists have neglected the hopes and dreams—and the needs—of the people in our cities. . . .Should we not, by public and private assistance, in all parts of the country and at all levels of government, bring together the physical scientist, the biological scientists, and the practitioner of legal, political, and social science to work on such problems?"

And again, Frank Gregg, Executive Director of the Citizens Committee for the Outdoor Recreation Resources Review Commission Report, this morning said:

". . . the nature of the traditional conservation challenge has been fundamentally altered . . . . The new conservation does not signal a turning away from the traditional conservation arena. On the contrary, it calls for applying the experience and the stamina of conservation leadership to a broader range of objectives—to the quality of the total physical environment, and ultimately to the character of the American people."

Time after time after time throughout the three days of this conference, the speakers have enunciated a new challenge to the conservation profession.: "Broaden your concerns!" they have said, "We need a new philosophy of conservation for an urban America."

It is no longer enough for American conservation to concern itself solely with the impact of man upon water, land, and wildlife. So profound are the effects of men upon the surface of the earth that we must become deeply concerned about the impact of all this upon the destiny of humanity itself.

Conservation must absorb within its province of concerns as much wider preoccupation with human welfare and aesthetics than has hitherto been the case. Our parameters are stretching beyond the traditional concepts of multiple use. Conservation is no longer solely the preserve of wildlife managers or foresters or hydrologists or recreationists or agronomists. It has grown beyond the old-line resource professions to embrace landscape architects, climatologists, urban planners, experts in economic development, social scientists and a host of other professions.

Our old primary concern was with the land and its resources. Our new concern centers upon people. Mr. Coté told us this afternoon that human resources are the most important.

Our old concern was with whether there would be enough resources to sustain future civilization. Our new concern must be not only with "how much"? but with "how good"?

But when I say "old" concerns, I may be stretching a point. After all, the philosophy of conservation is only a century old on the North American continent. It was born in the brain of that remarkable Congressman from Massachusetts, George Perkins Marsh, and broadcast in 1864 in one of the most prophetic books ever written by an American, "Man and Nature."

Scarcely anything we have heard in this conference would have struck Marsh as particularly surprising. A hundred years ago he saw where the creation of giant cities, the plowing of the land, the logging of the forests, the damming of the rivers, the polluting of the atmosphere and waterways would eventually lead us. Man's impact upon the face of the earth disturbed him profoundly, for one day in the future he saw humanity reaping a grim reward.

And in that wholeness of vision American conservation was born. For almost 40 years after Marsh, American conservation was a philosophy worried about by the impact of industrial America upon a lush and virgin continent. In those early years man's fate was seen as interlocked with the climate, forests, rivers, land and wildlife of the earth. From a *philosophy*, conservation evolved into a *movement* in which a dedicated band of amateurs enlisted. There were no resource professions to speak of.

But then, about the turn of the century, American conservation entered a new stage. The first professionals began to arrive—trained foresters, fish and wildlife experts, hydrologists, and agronomists. From a *philosophy* and a *movement,* conservation evolved into a *science*—a highly technical science.

And a science it is today, as the technical sessions of this conference make very clear. Look at the program. We have talked about radioisotope techniques in fishery research. We have talked about nematode infections in cervid nervous systems. We have talked about feeding coactions between snowhoe hares and deer.

But in becoming professionalized, American conservation lost something. Take that staunch old forester, Gifford Pinchot, as an example. He did not hold much truck with Marsh's notion of the "wholeness" of nature. No, he said, forestry is not worried about greenery, or recreation, or water supply, or wildlife. Forestry is worried about one thing: growing trees as a crop. "Timber production is the chief object of forestry," said Pinchot. And any other benefits you might get from practical forestry are happy, but accidental, by-products.

Nobody has a higher regard for Gifford Pinchot than I, but I think it is time we realized that something was deficient in his view. Today under the impact of an omnious explosion in world population and the concentration of most of these billions of people in massive metropolitan centers, something of Marsh's "wholeness" of vision must be restored if conservation is to play its proper role in improving and preserving man's environment.

After all, we cannot allow our asphalt streets, our kitchen faucets, our air conditioning to let us forget for a moment that man is an animal and just as much a creature of nature as any other. We are sustained by the air, fed by the earth, preserved by the waters of this planet, just like any other living thing.

But we have let our technology delude us into thinking that we are somehow set apart from the rest of earth's inhabitants in such matters.

Many of you are experts in fish or game management. Consider what your forecast would be for the future of an animal that was threatened by no beast of prey except itself, was slowly finding ways to avoid death from disease, and yet displayed a persistent tendency to reproduce its numbers without respect for the limitations of its feeding range. And to top it off the species showed an almost suicidal impulse to foul its own habitat!

You would predict decimation in short order, I suspect, and declare an open hunting season in order to cut down the number of animals on the limited range.

We have heard a lot at this convocation from animal pathologists. Suppose you were a pathologist out on Mariner II halfway from here to Mars and you looked back through a telescope at the continent of North America. Through your very remarkable instrument you detected a creeping fungus-like growth crawling across large areas of the continent. The growth seemed to proliferate before your eyes, blotting out other kinds of life in its path, sealing off the earth, fouling the water, corrupting the atmosphere. To you, the planet would appear infected by a virulent organism, and you would conclude that eventually the host planet would be so smothered by its parasite that the parasite itself could no longer be sustained.

To that astro-pathologist in outer space, man would appear to be a disease of planet earth.

The task of conservation in the years ahead is to convert man from a parasite of earth to its steward and its husbandman—not just because we enjoy the beauty and bounty of the earth for its own sake—though we do—but because the continued existence of civilized man himself is involved.

The new conservation must unite the resource sciences with an aesthetic for a new America. We must make sure that from here on out, as one of our speakers put it, *we* are running our technology and *it* is no longer running us. Technological know-how must become the chief handmaiden for creating and preserving a balanced, healthy, and beautiful environment capable of supporting man and his fellow creatures indefinitely. It must no longer be the "Great Destroyer."

In our sessions these last three days we have wrestled with the new conservation in all three of its aspects: as a science, as a movement, as a philosophy.

In our scientific discussions we have found that the most advanced techniques of science can help us find out how man can maintain his equilibrium with his mother planet. We have explored, through advanced techniques, the question of how much pollution from an oil refinery fish life can stand. We have examined some of the effects which watershed development can have on our streams and rivers. We have discussed the application of modern medicine to our fellow animals to help them combat the ravages of disease too.

Seven speakers discussed ways in which, despite human encroachments upon the land, we can still assure a place for waterfowl and other wildlife.

We have analyzed the techniques of multiple use management in order to make the wisest use of all our land and resources—wildlife, fishlife, forests, waters and air. Ironically, we have talked about how to keep wildlife populations in balance while pointing out that we have yet to keep man's *own* population in balance.

But we also realized that unless all this scientific intelligence can become a part of public policy, conservation can never get out of the laboratory. It must become the backstop to an informed public opinion.

That is why one entire session was devoted to making conservation effective as a movement. As one of the speakers on that program, Frank Gregg, commented:

"Conservationists have long accepted as a basic article of faith the interrelationship of resources and the community of living things. We've called it ecology, or the Web of Life, or simply conservation, and we've urged that the concept be recognized in public policy.

"Now the political leaders of the land are articulating this concept and outlining a comprehensive action program consistent with it.

"We are no longer, in short, prophets without honor. Nor need we pursue our special objectives in isolation."

Conservation today has become a potent political force. Its impact is being felt every day through the mass communications media and our educational system.

Mr. Gregg is correct, we *are* no longer alone.

But now comes the real test.

For years we have been asking Congress for the tools we need. And for the last several years we have been getting one right after another.

We have the Classification and Multiple Use Act.

We have a Water Resources Research Act.

We have a Land and Water Conservation Fund.

We now have a National Wilderness Preservation System.

We have a Wetland Acquisition Program.

We have a Public Land Law Review Commission.

We have an Economic Opportunity Act which establishes a Youth Conservation Corps for work on our public lands.

We have an Appalachian Act, signed only yesterday, that can become a potent vehicle for resource improvement and preservation in our eastern mountains.

Now in process we still have more:

There is a Water Pollution Control Act, already approved by the Senate.

There is a Wild Rivers Preservation Bill now before both Houses.

There is a Water Resources Planning Bill on its way through the legislative mill.

There are good prospects for a major Air Pollution Bill in this Congress.

The President will soon be sending a scenic highway proposal to Capitol Hill.

And there is renewed emphasis upon making our city environment more livable.

Now the question is, do we professional conservationists have the know-how and the breadth of vision to make all these programs work?

Do we have what it takes to restore the resources of this continent? Do we have what it takes to develop a working philosophy capable of reconciling all the conflicts of resource use which a growing, industrialized, urban population inevitably will engender? Can we help convert an ugly America into America the Beautiful?

Ernest J. Nesius, Vice President of the Center for Appalachian Studies at West Virginia University, put it to us:

"As the country continues to populate and to industrialize, which has a marked effect upon the quality of life, we are becoming increasingly conscious of the problem of social adjustment to a variety of adverse effects of technological change and economic growth," he observed. "In contrast to being concerned with the scarcity and allocative problem of natural resources, we are now concerned with the human being, his life, his environment, and his satisfactions. Our concern must center on: pollution of the air and water; pesticides and their effect on wildlife; disfigurement of the hillsides; and beauty and order in the urban areas and in the countryside."

In short our challenge—the challenge raised by this 30th North American Wildlife and Natural Resources Conference—is whether we can convert modern man from a planetary disease into the most constructive force in nature. Can we be creators instead of destroyers? Are we wise enough to sacrifice a few short-term profits for a long-term profit? Can we finally realize that the rape of a virgin continent has come to an end and that we must learn the art of nurturing a hurt and wounded land back to health?

We have the science. We are getting the public and political support. Have we the will and the know-how to meet this challenge? The President has said it as well as anyone:

"We built this Nation to serve its people," he said in the State of the Union message. "We want to grow, and build, and create. But we want progress to be the servant and not the master of man. We do not intend to live in the midst of abundance isolated from neighbors and nature, confined by blighted cities and bleak suburbs, stunted by a poverty of learning and an emptiness of leisure."

We must ask, he said, not only how much, but how good. Not only how to create wealth, but how to use it. Not only how fast we are going, but where we are headed.

The new conservation must provide some of the answers to those questions.

CLOSING REMARKS

C. R. GUTERMUTH
Vice President, Wildlife Management Institute, Washington, D. C.

Friends, it is believed that you agree that this 30th North American Wildlife and Natural Resources Conference has been one of the most successful of all of these annual meetings. After listening to that splendid critique and summarization by Maurice K. Goddard, you can see why we were delighted when Maurice accepted this important assignment. Appraising the program of a meeting of this size is a major undertaking. You did an outstanding job, Maurice, and we are grateful for the time and effort that you devoted to developing an outstanding appraisal that will be of great benefit to us in planning future conferences.

In behalf of the Wildlife Management Institute, which sponsors these yearly conferences, I wish to thank not only Dr. Goddard but all of the many organizations, agencies, and individuals that contribute to the success of these yearly conferences.

Sincere thanks go to The Wildlife Society in particular, and especially to C. Edward Carlson, who represented the Society as chairman of the technical program. The members of the General Program Committee, which includes the heads of most of the national conservation organizations and large federal agencies, already know how much we appreciate their help, and Ed Carlson is singled out for special commendation because he handled the many preliminary details with such thoroughness and dispatch. The programs of the technical sessions certainly reflect his efficiency.

Speaking for all of the conservationists throughout North America —thanks to the press. While I do not have much time to look at newspapers during these conferences, it seems to me that the Washington papers have done a most inadequate job in covering the program of this large international conference. It is hoped that the wire services and other periodicals have done a little better. Dan Poole worked hard to provide the press with abstracts of papers, with copies of complete papers, and with prepared releases highlighting the many talks of national significance.

In your behalf, as well as that of the Institute, thanks to the Statler Hilton Hotel and the Washington 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 seemed as though all of you enjoyed last night's banquet. This is a large ballroom, and both the Presidential and Congressional rooms were filled to capacity. Judging by the way in which it was applauded, the musical and variety show produced by Jack Morton Productions was up to standard.

The members of the Institute staff always are relieved when these annual conferences come to a close. After all these years, you would think that we should have learned how to simplify the handling of the innumerable details. Instead, however, the tasks seem to become more arduous.

Now, we come to the time when I have the privilege of expressing my gratitude to those ladies who keep Dr. Gabrielson and me going throughout the year and during these large conferences. It gives me great pleasure to once again ask that Mrs. Gabrielson and my good wife, Bess, stand and receive the ovation they deserve.

I am pleased to say that the registration was all that we expected. We are specially delighted by such cooperation as that of the States of Idaho, and Nebraska. There were 1236 enrolled at my last check, and when it is known that we never can get more than about 85 or 90 percent of the people to register, this means that we have over 1,300 in attendance. We had 787 at the annual banquet last evening, including many Senators and Congressmen and many of the heads of the federal agencies at the head table. Again I wish to say that neither the registration nor the attendance record is our measure of success of these yearly conferences. The things that count most are the overall program, the participation in the floor discussion, the good that comes from the related meetings, and the personal contacts that are made. These count much more than the number of people.

Now then, we have made definite arrangements for next year's conference. I am pleased to announce that we are going to Pittsburgh in 1965. The headquarters hotel will be the Pittsburgh Hilton, and the dates will be March 14, 15, and 16. It is hoped that you will be there. Thanks, and a safe trip home. Happy landings!

REGISTERED ATTENDANCE AT CONFERENCE

ALABAMA

Ralph H. Allen, Jr., Maurice F. Baker, I. B. Byrd, Luther Durham, Pete Farrar, W. L. Holland, Charles D. Kelley, Raymond D. Moody, John Spaulding.

ALASKA

Bud Boddy, Mrs. A. W. Boddy, James W. Brooks, Frederick C. Dean, Ernest Gruening, Wilbur L. Hartman, B. Frank Heintzleman, David R. Klein, Sig Olson, Ralph J. Rivers, Robert B. Weeden.

ARIZONA

Milton G. Evans, Paul J. Fannin, Morley E. Fox, Steve Gallizioli, Roger Hungerford, Robert A. Jantzen, Lyle K. Sowls, Wendell Swank, O. C. Wallins.

ARKANSAS

Harold E. Alexander, Mrs. Harold E. Alexander, William J. Allen, Mrs. William J. Allen, W. M. Apple, Nelson Cox, Charles Davis, Dane Donaldson, D. N. Graves, Newt L. Hailey, Sam Holt, Kirk Strawn.

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