TRANSACTIONS

of the

TWENTY-FIFTH NORTH AMERICAN WILDLIFE AND NATURAL RESOURCES CONFERENCE

365um 11/4/60

Conference Theme:

NATURAL RESOURCES AND
AMERICAN CITIZENSHIP

March 7, 8, and 9, 1960

Statler - Hilton Hotel

Dallas, Texas

Edited by James B. Trefethen

Published by the
WILDLIFE MANAGEMENT INSTITUTE
WASHINGTON 5, D. C.
WIRE BUILDING
1960

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

PRINTED IN
U. S. A.

Printed by
Monumental Printing Co.
Baltimore, Md.

WILDLIFE MANAGEMENT INSTITUTE

OFFICERS

IRA N. GABRIELSON, *President*
C. R. GUTERMUTH, *Vice-President*
RICHARD F. WEBSTER, *Treasurer*

Program Committee

C. R. GUTERMUTH, *Chairman*
JOHN L. BUCKLEY *representing* THE WILDLIFE SOCIETY
as Chairman of the Technical Sessions

A. D. ALDRICH, *Past President*
Int'l Ass'n of Game, Fish and Conservation Comm's, Tallahassee

ENRIQUE BELTRAN
Assistant Secretary of Forests and Game, Mexico, D. F.

CARL W. BUCHHEISTER, *President*
National Audubon Society, New York, New York

HENRY CLEPPER, *Executive Secretary*
Society of American Foresters, Washington, D. C.

CHARLES A. DAMBACH, *President*
The Wildlife Society, Worthington, Ohio

HOWARD D. DODGEN, *Executive Secretary*
Game and Fish Commission, Austin, Texas

JACK DYER, *President*
American Ass'n for Conservation Information, Little Rock, Ark.

OLLIE E. FINK, *Executive Secretary*
Friends of The Land, Zanesville, Ohio

FRED E. HORNADAY, *Executive Vice President*
American Forestry Association, Washington, D. C.

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

W. MASON LAWRENCE, *Past President*
American Fisheries Society, Albany, New York

ROSS LEFFLER, *Assistant Secretary*
Department of the Interior, Washington, D. C.

W. WINSTON MAIR, *Chief*
Canadian Wildlife Service, Ottawa, Canada

E. BUDD MARTER, III, *Executive Director*
Outdoor Writers Association of America, Baltimore, Maryland

C. W. MATTISON, *President*
Conservation Education Association, Silver Spring, Maryland

RICHARD E. MCARDLE, *Chief*
U. S. Forest Service, Washington, D. C.

MAX MCGRAW, *President*
North American Wildlife Foundation, Chicago, Illinois

FAIRFIELD OSBORN, *President*
The Conservation Foundation, New York, New York

JOSEPH W. PENFOLD, *Conservation Director*
Izaak Walton League of America, Washington, D. C.

ANTHONY W. SMITH, *Executive Secretary*
National Parks Association, Washington, D. C.

SPENCER M. SMITH, *Secretary*
Citizens Committee on Natural Resources, Washington, D. C.

RICHARD H. STROUD, *Executive Vice-President*
Sport Fishing Institute, Washington, D. C.

ARNIE J. SUOMELA, *Commissioner*
U. S. Fish and Wildlife Service, Washington, D. C.

ERNEST SWIFT, *Executive Director*
National Wildlife Federation, Washington, D. C.

ALVIN C. WATSON, *Past President*
Soil Conservation Society of America, Upper Darby, Pennsylvania

RICHARD W. WESTWOOD, *President*
American Nature Association, Washington, D. C.

DONALD A. WILLIAMS, *Administrator*
U. S. Soil Conservation Service, Washington, D. C.

CONRAD L. WIRTH, *Director*
National Park Service, Washington, D. C.

HOWARD ZAHNISER, *Executive Secretary*
The Wilderness Society, Washington, D. C.

GORDON K. ZIMMERMAN, *Secretary*
National Ass'n Soil Conservation Districts, Washington, D. C.

Ladies' Committee

MRS. JOHN L. BUCKLEY
MRS. CLARENCE COTTAM
MRS. HOWARD D. DODGEN
MRS. IRA N. GABRIELSON
MRS. C. R. GUTERMUTH
MRS. CHARLES A. WHEATLEY

* * *

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 25th North American Wildlife and Natural Resources Conference.

CONTENTS

PART II—TECHNICAL SESSIONS

DEPREDATIONS CONTROL SYMPOSIUM

WETLANDS AND INLAND WATER RESOURCES

FIELD AND FARM RESOURCES

COASTAL AND MARINE RESOURCES

FOREST AND RANGE RESOURCES

PUBLIC RELATIONS AND EDUCATION

PART I

GENERAL SESSIONS

GENERAL SESSIONS

Monday Morning—March 7

Chairman: Gordon K. Zimmerman
Executive Secretary, National Association of Soil Conservation Districts, Washington, D. C.

Vice-Chairman: Stanley B. Mulaik
President, American Nature Study Society; University of Utah, Salt Lake City, Utah

NATURAL RESOURCES AND INDIVIDUAL NEEDS

FORMAL OPENING

Ira N. Gabrielson
President, Wildlife Management Institute, Washington, D. C.

This marks the beginning of the 25th North American Wildlife and Natural Resources Conference, the first of these international meetings to be so designated since the name was changed to North American Wildlife Conference at the history-making event in Washington, D. C. a quarter of a century ago. Even in 1936, the Conference was not exclusively a wildlife conference, and this new title more accurately describes the type of meetings that have been held in recent years, and which are being started here today. Each year there has been present at these meetings, in increasing numbers, organizations, agencies and individuals whose primary interests are in forestry, soil, water and related conservation fields. This is as it should be, for the fate of wildlife is closely bound to the treatment given to the soils and waters of this land and to the type of vegetation that those primary resources support. We have been discussing these problems for many years and hope that in the future even greater emphasis will be given to the coordination of man's management of the various natural resources.

For those of you who have not attended these meetings before, may I repeat a statement that probably is boring to some of the oldtimers that are here. This is a conference, not a convention. It is a forum where individuals, conservation organizations, governmental agencies, and scientific societies are welcome to come to listen or to participate in the discussions. No resolutions are passed, and no formal actions are taken. These properly are the prerogatives of the various organizations that are represented here, either officially or unofficially. Therefore, the Chairman of each session will be instructed not to entertain any motions nor to formulate any resolutions or recommendations.

Since our last Conference, a number of important actions were taken by the Congress. The most significant from a conservation standpoint, was the large majority by which the Blatnik bill, for strengthening the Federal Water Pollution Control Act and expanding the total authorization for grants-in-aid for cleaning up the nation's waters, was passed. The measure was passed by both Houses of Congress in the first session and was in conference at the time of its adjournment. Since Congress reconvened in January, the bill was cleared overwhelmingly by both Houses. The Presidential veto, which Congress failed to override, clearly shows that clean water for industry, public welfare, and national security is of less importance to the present administration than to those elements of our economy that comprehend the seriousness of the water problems. The chief opponents of legislation for cleaner waters have been the Chamber of Commerce of the United States and the National Association of Manufacturers. Apparently, their influence is more potent with the Administration than that of the millions of Americans who must continue to tolerate polluted water because of a penny-wise, pound-foolish budget economy.

A few figures for comparative purposes might be of interest. Although the approach to federal participation in vital domestic water pollution abatement programs has been characterized by heel-dragging and pious regard for a balanced budget, this same Administration, between 1955 and 1959 provided, through the International Cooperation Administration, outright gifts to foreign countries for sewage treatment plants and sanitary services totalling $48.5 million dollars! Perhaps we will succeed in cleaning up the Ganges ahead of the Potomac.

Another point of interest is the degree of local participation in the over-all national program. Federal grants to the states to date total $131.6 million while the communities and states that have benefited have contributed $553.6 million. This program has stimulated $4 in local participation for every $1 in Federal assistance. Few other federal grants programs can boast such a degree of local financial support as the pollution control program. The Federal highway program, for example, offers $9 in Federal aid for each $1 of state participation.

Passage in the first session of this Congress of a bill authorizing a much enlarged fund for research into the effects of pesticides upon wildlife raised hopes that more money would be requested this year. When the President's budget was published, however, there was great disappointment to find that there had been no increase in the amount allowed to the U. S. Fish and Wildlife Service for pesticides research. Conservation organizations went before the House Committee and asked for an increase in the appropriation in line with the new authorization, but it is too early to predict what the final outcome will be when the bill gets through Congress. The Interior Appropriations Bill, which already has been passed by the lower House, recommended only the $280,000 requested by the Bureau of the Budget.

On the other hand, conservationists were heartened by the recommendations in the President's recent farm message that the amount of land in the Conservation Reserve of the Soil Bank be augmented through an orderly expansion up to 60 million acres and that more money be made available. This is a step in the right direction, and it is hoped that this marks the beginning of the end of the payment of subsidies for drainage, land clearing and for other questionable practices that are unnecessarily destructive of wildlife values and also add to the over-all farm problem. Conservationists long have criticized the subsidization of drainage operations, and there has been a growing volume of criticism of brush clearing in various parts of the country, particularly in Texas, as the long-time effects of these operations are beginning to become apparent. From a conservation standpoint, it would be far better to pay the farmers a flat subsidy to retire land rather than pay them to do things that add to the agricultural problems and which, at the same time, complicate and interfere with proper administration and production of valuable wildlife resources.

There has been a growing volume of criticism of the widespread use of the inadequately tested and highly toxic poisons for controlling various agricultural, rangeland and forestry pests. The fire ant eradication program has been under severe attack because it is not aimed at an insect of major economic importance but at one that most informed conservationists believe is merely a nuisance rather than an economic pest. Particular criticism has been directed at the large-scale blanket aerial spraying of poisons like heptachlor, dieldrin, and other very deadly substances, and spraying them indiscriminately over hundreds of thousands of acres rather than treating infested areas. The U. S. Department of Agriculture has been criticized repeatedly for its activities in fire ant and gypsy moth control and most recently, for aerial spraying to control Japanese beetles in the Detroit area. The result of all of this has been to put the Department of Agriculture in the position of defending single-purpose operations so that it now appears that the Department is interested in control above everything else, regardless of the effects on wildlife, on human health, and other factors in our economy. Criticism of these practices will continue to grow as long as there is carelessness or incompetence in handling these exceedingly dangerous materials.

In addition, there is much more concern over their possible effects on public health, and the Public Health Service has, as you know, become quite active in checking on the distribution and use of some of these substances. Their latest action eliminated any tolerance of heptachlor or its residues on a wide variety of crops grown for human consumption or for feeding to dairy cattle and to animals whose meat will be used in human consumption. This seems to be a significant approach to some of these problems and one that may cause additional restrictions as more becomes known of the immediate and long-time effects of some of these chemical on human health. For the present, the Health, Education, and Welfare Department seems to be the cast in the role of protecting the people against the operation of any agency that is bent toward the single objective of control of insects and other pests.

Through some unfathomable logic, the Bureau of the Budget saw fit to approve again this year the full $2,400,000 requested by the Department of Agriculture for the controversial fire-ant eradication program while slashing, by nearly 90 per cent, the approved authorization for studying the effects on wildlife of the lethal substances that are being disseminated under that and other pesticidal programs.

In discussing the conservation program of the Administration, I would be remiss if I failed to point out some of the bright spots. I have mentioned already the expansion of the Soil Bank Program, which President Eisenhower has advocated and which conservationists in general applaud. The courageous and forthright action of Secretary of the Interior Fred Seaton in saving the Tule Lake National Wildlife Refuge from destruction at the hands of local water users deserves a real accolade. He also has proved himself to be one of the staunchest bulwarks in government against the military invasion of wildlife refuges and national park areas.

If I have one criticism of the Secretary it would be because of his failure or reluctance to build a few fires in his own department. I refer to the long-awaited, long-range program of the U. S. Fish and Wildlife Service that we have been hoping to see appear for several years. The National Park Service's Mission 66 program is well on its way to completion; the Forest Service's Operation Outdoors is well under way; and the Bureau of Land Management overcame a late start and has its program prospectus ready for public scrutiny. The Fish and Wildlife Service's long-range program has been in the mill for years, but it still does not have even a fancy name. Those of us in conservation work could put such a report to excellent use, and it is high time that some one starts to ask pointed questions of its whereabouts.

The Wilderness bill has been subjected to extensive hearings in Washington as well as numerous field hearings throughout the West. The bill itself has been modified to take into account all of the valid objections of its opponents. It has strong public support. It is languishing at the present time in the Senate Interior and Insular Affairs Committee where, through the filibustering tactics of two Senators, its legislative progress is being delayed. It always takes time before the public begins to put its foot down on major conservation legislation to the elected representatives in Washington.

We are faced today with another crisis in waterfowl management comparable to nothing since the great drought of the 1930's. Due partly to the shortage of waterfowl, partly to curtailed hunting regulations, and partly to the increase in the price of the Duck Stamp, the sales of the stamps have lagged badly. Purchases are falling 23 per cent behind those of last year. Under the provisions of the amended Duck Stamp Act, the funds obtained can be applied more fully and more directly to waterfowl restoration than at any time in the past, and the Duck Stamp revenue is more badly needed today than at any time in the past 15 years. I urge everyone interested in waterfowl, whether a duck hunter or not, to purchase one or more of these stamps, and I would like to see a concerted campaign by every organization and agency here represented to push the Department of the Interior's publicity campaign to promote the after-season sale of duck stamps. The need is urgent, and the project is worthy of widespread public support.

It is a pleasure to welcome you here to this meeting in Dallas. We hope that you will enjoy the meetings, that you will benefit both from the formal programs and the innumerable conferences, get-togethers, and just plain "bull sessions" that always are going on at a conference of this type. Despite the Alaskan type weather with which Texas has greeted us, we hope you will have a good time and will enjoy yourselves, but we hope that everyone will learn something that will take you back home equipped with a better knowledge and understanding of the problems connected with the management of natural resources.

OUR SOIL — OUR STRENGTH

LLOYD W. LOWREY

Chairman, Natural Resources, Planning, and Public Works Committee, California Legislature, Rumsey, California

There is probably no better way to begin this discussion of soil conservation and its importance to mankind—to me, first as a farmer and secondly as a legislator—to you, our children, and their children —than to quote from an address presented before the recent convention of the Society of American Foresters.

The foresters were told:

"There is no room for compromise with loss of soil."

The speaker certainly could not have put it better—there can be no compromise with loss of soil for any civilized man, be he forester, wildlife expert, union man or industrialist; whether he lives in a rural environment or an urban area—it matters not.

Our Union of States represents to many millions of people—from all over the world—a land of abundant natural wealth, manifested in an almost unlimited variety of forms, offering to each prospective resident the kind of environment he most desires.

To preserve what remains of such an array of natural riches is going to require all our foresight and skill in adapting our operational procedures to the problems of land management.

Since much of our agricultural soil resource is under private ownership and management, within the power of individuals to build up or tear down, it is obvious that conservation of our land must be directed at the "grass roots" level instead of from remote positions in government, but for the approximately 50 per cent in governmental ownership particularly in the western states, some means must be adopted to induce government to wisely manage the areas under its stewardship, as well as those under the individual farmer's stewardship.

It was to protect the fine tillable soil in private ownership that our first soil conservation districts were formed in the 1930s; and because this proved to be the right kind of approach, the United States of

America now has these districts covering a dominant portion of her total land area.

This has been a monumental achievement, brought about by dynamic people who have had a strong love for our land and other natural resources, including but not limited to wildlife. In dedicating their time and other personal resources to this movement, conservation-minded citizens serving as directors of soil conservation districts have performed an incalculable service to all of us, and to future generations.

During the month of November, three hearings were held by the Assembly Interim Committee on Natural Resources, Planning and Public Works, of which I am honored to be chairman.

On this committee, besides myself, were Assemblymen representing metropolitan areas where the great concern is sewers, streets, fire prevention, smog, police action and other day-to-day, immediate problems of urban living.

So numerous are these ever-present trials of the moment, and so pressing are the groups promoting each, that it seems fair to say and I think my colleagues would agree, they had never really had the privilege of fully understanding just what soil conservation means to the city dweller.

This same entanglement with the day-to-day problems and activities, in most fields of endeavor, has kept the stark and terrible truth of the importance of soil conservation from reaching many of us, yes even some of us foresters, ranchers and even champions of the necessity for wildlife conservation.

Yet each and every one of us is bound tightly in the network of circumstances, in the chain reaction of catastrophe which loss of soil can bring to our very cities in spite of all our engineering and planning, to our forest programs, our wildlife programs, our marketing programs, even our governmental activities and our way of life as free men.

It has happened many times before.

It happened in Greece, Plato tells us.

The hills of Attica in ancient and time-honored Greece were destroyed by man's ravishment of the soils. They used to be covered with fine trees, beautiful pasturelands, crops of wealth—until the ignorant abuses of man coupled with the violence of nature destroyed the lifegiving top soil of Attica.

Is it difficult for one to call the historic and democratic Greeks "ignorant"? They built a magnificent civilization, tasted early fruits of intellectual and personal freedom, in spite of still retaining a few slaves. They chose one of the most idyllic climates for this cultural growth—a climate not too unlike that of California.

But, like many Californians today, they could not, or did not, fathom the value of a cubic foot of topsoil to their civilization.

Other than that brief mention by Plato, the heritage the Greeks left us was, as were the heritages of all previous civilizations, barren of this essential, an appreciation of the fact that soil is our life, necessary to the culture of mankind.

Man has long known the value of water. The Romans built magnificent aqueducts, aqueducts which would make us taxpayers of today scream even more loudly than we do. But they did not recognize soil as the first essential, and today there are places in southern Italy where people are going to the mouths of rivers and actually carrying topsoil back to the benchlands in order to grow a bare subsistence—an existence we, in only partially ravished America, cannot fathom.

These pitiful plots cost our brothers in Italy an incalculable price, far more than thousands of dollars an acre. Misery and semi-starvation are difficult to evaluate with dollar signs.

These destitute and debased men, women and children may know the value of a cubic foot of topsoil—but their nation does not; nor do we in America, as is evidenced in some of our recent legislation.

Perhaps it is because topsoil and humanity are so closely aligned, and maybe we are not yet sufficiently humane.

There is a law which, at present, is a tool our state conservationists are permitted to use to harness rainfall in small watersheds.

It is U.S. Public Law 566, supposed to help us control floods, and thereby erosion.

For citizens in a troublesome watershed to be permitted to use this law and its funds, appropriated for dams, local watershed representatives must show that it is a financially feasible project. That is, the cost in dollars must not be more than the value received, as expressed in dollars.

Various things enter into this dollar benefit, such as crop losses of the past and loss of livestock in floods.

But U.S. Public Law 566, too, lacks that essential understanding and evaluation of soil conservation. It even lacks elemental humanity. Though prevention of loss of cattle is considered a benefit, the fact that human lives were lost in a flood, and a flood control dam would prevent this in the future, is not considered a benefit.

Nor is there any provision for considering the saving of topsoil as a benefit, topsoil which otherwise might be washed away to the sea.

How do you figure the dollar value of a life, or of the soil—which means life, which means the future of mankind, the future we leave for our children and their children?

What then is the value of a cubic foot of topsoil?

It is simply this: A decent, wholesome and free life for the future of all of us—as opposed to misery and poverty and bondage for the great majority of us.

Yes, for us, because the products of our loins, the generations to come, will carry with them some part of us.

California is an up and coming state, has always been so and appears to be gaining momentum in material progress at an accelerated clip.

We have some of the largest airplane factories in the world.

We produce some of the most advanced electronic equipment in the world, setting a pace to be followed.

Our university system is the largest in the world, and we have staffed it with big names in the sciences.

We are a leader in forest genetics, the development of new trees for more efficient timber crop production.

We produce some of the finest wines in the world, have some of the most beautiful cities, some of the most elaborate super highways.

These we are proud of, and many more areas of accomplishment too. And well we should be. They can contribute much to our freedom, to the good life of us all.

That is, they can contribute much provided we are able to support these ingenious mechanical contrivances of ours, and the other great strides which are just around the corner.

That, of course, is considered simple by many who give it little thought. Our chemists will figure out a way, they say. Already we can raise plants in fertilized water. We can make foods out of algae. We may soon be able to make artificial diets that will be artificially flavored and pepped up with artificial vitamins, proteins, carbohydrates and other things we know to be essential for life.

I, for one, do not choose to consider it the good and bountiful life if I must eat an artificial steak made of algae—even though I might be able to exist upon it.

But aside from this preference, not one of these dreams has been proven practical for the tremendous production which we must maintain to feed the world—even with today's population. And at the rate the population is growing, it will make the tremendous food production, proudly necessary today, appear trivial in the not too distant future.

Medical doctors are directly involved and should be keenly concerned, since this tremendous growth in population is made possible to a considerable extent, through the conquering of the ruthless natural elimination of many persons before they have had the opportunity to live out their normal life span. Yes, the doctors are intimately involved.

We must leave for the future at least as much toward the good life as was here when we came in—or we have been complete wastrels And we are today complete wastrels, just as were our ancestors, in spite of our vaunted technological progress.

Our electronics industries may aid for a while, ersatz food may help for a while, but then they too will wither for lack of nourishment They will become pointless.

But by that time there will be no more virgin lands to migrate to, no way in which can can slip back to hand-to-mouth living from the good earth.

There will be no good earth. It will be gone, as surely as if it had eroded into the sea, covered by the very "things" which man is putting his faith in for a better future—huge cities, sprawling subdivisions devouring our Class I ranch lands, super highways consuming acres upon acres of irreplaceable ranch lands, and continual erosion of what ranch lands are left through the improper application of engineering to flood control.

Today we build magnificent levees, down where the rivers are wide, where the rivers cause great flood damage. As civilization spreads these levees from time to time give way and must be rebuilt by our engineers again—and again and again. There is an end in sight for all of us, if that is the way we continue to fight floods.

And while all this is being done, those high cost levees are speeding most valuable waters on their way to the sea, laden with soils from the rich upstream valleys.

Then how can we profitably control these ever menacing floods down stream? Certainly not by building ever larger levees.

There is only one way we can begin to control this terrible waste of water, and life giving soil. That is by building dams in the upper reaches of the rivers and their tributary streams and arroyos, and holding that water there until it is needed downstream, until it can be safely sent into the lowlands.

And while we are holding these waters in the upper reaches we also are stopping most of the erosion.

And by stopping the erosion we are improving the quality of water which does come down.

And we are increasing by many, many millions of gallons the water which can be used in our cities and factories and on our agriculture of the lowlands, and at the same time adding millions of gallons of water to the underground water table—another most valuable resource which we are depleting. Land has dropped as much as 16 feet in the San Joaquin Valley due to excessive lowering of the underground water table.

So it is seen that as we protect the soil, which we must have in order to live, we also are building ever greater wealth—much of which can be figured with dollar signs.

Now, there are those who publicly proclaim we will be pioneering on other planets before we run out of food on earth (they do not speak in terms of food producing soil). They say that this will solve our population pressures, which are growing almost with the speed of light.

Let us look into it to see just what the probabilities are, and how much it would cost us.

In the first place our scientists say that Mars and Venus, the only two possibilities in our own solar system, probably cannot sustain our type of life. We may possibly put down temporary and very elaborate scientific parties, but colonization is not in the cards.

That means we would have to go outside our own solar system.

The nearest star, which for the sake of pioneering we will assume has planets on which we could live, is Alpha Centauri, 413 light years away.

How long would it take us to get there?

Our current rockets being readied for the moon are supposed to travel about 19,000 miles per hour.

If we take one of these rockets, as our version of the mid-20th century covered wagon, to new frontiers, it would take us 129,000 years to reach Alpha Centauri.

That is right—129,000 years.

Now, there is one visionary who thinks that, within several centuries, we just may be able to attain an average speed of seven million miles per hour in space. That would cut down our trip to Alpha Centauri to 350 years.

Of course on this trip we would have no freedom whatever. Population control would have to be strict. It would be a truly austere program—350 years in a space ship. Ten generations.

But some persons may want to do this anyway.

How much will it cost us taxpayers to send our surplus population to Alpha Centauri?

Garret Hardin, of the University of California at Santa Barbara, has figured it out, assuming that mass production of a superior type is employed, at $50 a pound for the space ship.

This, Hardin says, will cost three million dollars per man, or woman, traveling in the space ship.

Our population is increasing at about the rate of three million people a year. To ship this population increase off would cost nine thousand billion dollars a year.

Our gross national production is almost 450 billion dollars a year.

This means that to solve our national population problem by space pioneering we would have to spend 20 times as much as our entire income on the purpose alone, allowing nothing for any other purpose, not even food.

But we live in a world which also is growing at an alarming rate. Hardin has figured out how much it would cost to ship off just one day's population growth of the world to Alpha Centauri—about 369 billion dollars a day.

As a legislator who hears, and hears often, what the taxpayer thinks of his present taxes, I can tell you this is out.

We have no alternative. We must be provident. We must save our soil, our life-giving soil—or perish; perish as have so many vast empires that history has recorded.

I believe now is the time. I believe we, as reasoning men and women, have finally become sufficiently cultured and humane, along with our self seeking, to recognize that soil conservation is the top priority program for all of us.

To make it top priority, it must be given that status in the governmental structures of the cities, counties, states, and nations.

Nationally, a soil and water conservation cabinet post must be established, which must offer guidance to all other branches of the Federal Government in any structural programming.

In each of the fifty states we can do the same—and quite possibly set the example for the rest of the nations of the world, as we do in so many other things—by recognizing soil and water conservation as the top item of progress for a fast progressing state.

Highways and other land consuming projects should be built with guidance of soil conservationists, and only with them as consultants of stature.

If you do not believe that this is essential, look to the rate at which our Class I and II land is being gobbled up by engineering projects of all kinds.

Especially notable is the Southern California area, classic examples being the San Bernardino-Los Angeles regions where just 20 years ago phenomenal farm production existed but which today have been displaced by urban population. This area is almost lost to farm production, though much of the soil was Class I land.

We have other problems in soil conservation too, such as atomic fallout and disposal of atomic wastes. But unless we save the soil we have now, we may not have to worry about it becoming contaminated.

What purpose is there to building monuments to technology, to making an ever more complicated "government by law" if we have no soil to support them? Where is the prestige in destroying the very earth which feeds us? We then are no better than the vinegar fly in a laboratory bottle which eats happily, breeds prolifically, until the "soil" which supports its food is depleted and there is no more food —because there is no more soil. And they all die.

But we are thinking people. And all of us, as citizens, must clamor for the most important item to be recognized as the most important, now, before we have no opportunity to do so.

And, as an active dirt farmer and legislator, I know it is up to you and me, as citizens, to determine what course we shall take.

As Willis Evans also told the foresters in beautiful San Francisco:

"The public should decide which, if any, resource should be eliminated. Soil belongs to we the people right now in the present and in the future."

You and I are the people; the future is in our hands.

DISCUSSION

DR. JOE NICHOLS [Natural Food Associates, Atlanta, Texas]: I am president of the Natural Food Associates, a nonprofit conservation organization. I understand the U. S. Department of Agriculture has in its files now a report which suggests by the year 1975 America may face famine.

MR. LOWERY: That is right. I attended a caucus a year ago in the Congressional Hotel breakfast meeting when the Secretary of Agriculture and some of his staff and technicians made that very same statement, and they said they could verify it. Several of the congressmen and senators took issue with them, pointing out that we spend millions and billions of dollars on farm surpluses.

They said that may be true, but by 1975 we very well could be facing a famine in the United States, and I would like to point to the fact, that if we would put an extra tablespoon of wheat flour in each loaf of bread we would have a palatable food to eat, and we would eliminate a great portion of this wheat surplus. We wouldn't need all these bins to store it in.

CONSERVATION FROM A RANCHER'S VIEWPOINT

A. P. ATKINS

Rancher, Guymon, Oklahoma

This will not be a sermon on the evils of soil erosion and its effects on the generations yet unborn. Neither will it be a case history of a successful conservation program on my ranches. Instead, it will be an attempt to promote a better understanding between two segments of our American population whose divergent attitudes toward our natural resources have often resulted in controversy within legislative halls, the courts, and in personal incidents. One group consists of the property-minded, land-owning, agricultural minority. In frequent opposition is the urban majority of our people, whose interest in natural resources is expressed chiefly in terms of scenery and recreation.

I am here as a representative of the ranchers who constitute a minority within the agricultural minority of our population. I accepted the invitation to appear on this program in the hope that I might make some small contribution toward mutual respect and understanding. Unless conservationists within both groups can find common interests and objectives, we may some day find that we have lost the resources we are trying to save. The passenger pigeon has long disappeared, and the buffalo and many other game species survive only in numbers too small for sport, while the disastrous effects of soil erosion have been amply demonstrated by floods and dust storms.

I wonder how many of you comprehend the revolutionary changes which are continuing to take place in American Agriculture. I suspect that ranching is more consistently misrepresented to the public than any other vocation. In order to dispose of any possible misconceptions, I want to assure you that modern ranchers have nothing in common with western novels, movies, or television serials except men and animals. Just as hunters no longer slaughter buffalo herds for their hides, we ranchers have also altered our practices and attitudes to fit the times, and neither hunters nor ranchers should be condemned for the excesses of former generations.

But if many of the first ranchers were selfish and domineering, if they overgrazed and monopolized the public domain, let us also remember that they could not have survived without certain qualities of toughness and stubbornness, and that they did bring about a degree of civilization in a previously uninhabited wilderness. And may it also be remembered that the sod busters who followed them have been equally guilty of destroying many thousands of acres of fine grasslands which we are now spending taxpayers' money to reclaim. It was wheat farmers, not cattlemen, who once created a "Dust Bowl" in the area where I have lived for 35 years. The silt which clogs the streams where many of you would like to fish comes from plowed fields, not pastures. And many forest and grass fires are started through the ignorance and carelessness of town and city people who have never been taught how to behave when they are outdoors. The waste of natural resources has been a national disgrace, but it is not an occupational disease.

Now, what is a ranch? Essentially, it is a factory which uses livestock to convert grass into meat. It may include some other enterprises, such as cultivated land, or even oil wells; it may in some instances provide entertainment for paying guests in season, but ranches as I know them are highly specialized business concerns which produce the best food in the world: MEAT. A successful ranch requires a relatively large acreage of land, considerable equipment, and the investment of a great deal of money—frequently borrowed money. However well situated and well managed, it is subject to the equally unpredictable hazards of weather and markets. Like every other business enterprise in America today, it carries a heavy burden of taxes and operating expense under constantly changing conditions.

In spite of the relatively small number of people engaged in livestock production, we should remember that something like 60% of the total land area of the continental United States is used primarily for grazing and hay production. Rangelands produce at least half of all feed eaten by our livestock. They are an extremely important source of water, and their mineral and recreational values should not be overlooked.

If I were to discuss all the technological changes which have affected ranching operations in very recent years, I would have to include: nutritional discoveries, antibiotics, hormones, cross-breeding, and artificial insemination, as well as such related developments as truck transportation, commercial feedlots, and supermarkets. From a conservation standpoint, the most important progress has occurred in the field of agronomy. Many thousands of acres of native grasslands which have been abused by overgrazing, depleted by drouth, or simply cultivated through ignorance, are now being successfully reseeded to the beautiful and productive grasses which originally covered them. New strains and varieties of grasses have been developed, along with mechanical and chemical methods of brush control.

As a result: (1) Ranchers are overcoming the errors of the past, (2) They are producing an abundance of food. In terms of purchasing power, meat is cheaper than ever before in our history. (3) They are building business enterprises which they are proud to own, and which they naturally want to protect and pass on to their children. (4) They are protecting not only their own land, but also much of the water supply of the Nation.

Conservation is a nice word whose connotations are many and varied. To some people it means fish and wildlife, to others trees and water and grass and productive soil. The word has been used for political purposes to disguise government subsidies which have little or nothing in common with conservation but the name. To me as a rancher, conservation simply means wise use of natural resources, with special emphasis on grass and water. This involves not only the restoration of depleted pastures and the revegetation of abandoned cropland, but also management practices which will achieve a sustained productivity over a period of years, whether the range be grazed by game animals, domestic livestock, or a combination of both.

I am not inferring that all ranchers are conservationists. Neither are all hunters and fishermen. I am only stating that range conservation is an accepted principle of successful ranch operation, and I am convinced that it is essential to economic survival in a highly competitive and financially hazardous occupation.

Neither am I suggesting that ranchers are blind to an appreciation of nature. Ranchers are outdoor people. Many of them like to hunt and fish. I think we appreciate nature as much as you people who live in town and understand it better. We are forced to adapt ourselves to the vagaries of climate and weather. Any man who endures drouth and blizzards has to have a certain respect for his surroundings; otherwise he would get a soft job in town and go to the country on weekends like many of you people do.

Ranchers are people, American citizens like our friends and relatives who live in towns and cities. Our point of view, like yours, is influenced by environment, personal preferences, and economic circumstances. We are not saints, but I deny that we are the villains which you wildlife enthusiasts and sportsman's organizations sometimes accuse us of being.

For instance: The American Society of Range Management is an organization dedicated to the conservation and improvement of the Nation's grasslands. Its membership includes some 3,000 scientists, technicians, and ranchers. In January 1956, when I was President of the Society, its annual meeting was held in Denver. One of the invited speakers was Mr. C. R. Gutermuth, then as now Vice-President of the Wildlife Management Institute and actively connected with other and similar organizations. I think he could properly be considered an accredited spokesman for wildlife and recreational interests. His remarks were widely interpreted as a blanket indictment against ranchers and livestock organizations.

I am not trying to build this incident into a public debate, although my opportunity is in every respect identical to his. But I think the ranchers' interests and contributions to conservation are entitled to sober and thoughtful consideration by the wildlife organizations represented here.

As regards public lands, certainly the public interest should have priority. I think you will find that western livestock organizations generally are on record in favor of the multiple use principle as opposed to monopoly by anybody. I do not intend to argue about the number of livestock which should use the public lands nor the amount of grazing fees. But if you and I were forced to share a ranch with hunters and fishermen, uranium prospectors and vacationists, and if we had to put up hay to feed the deer and elk through long winters, I don't think we would want to pay very much for grazing privileges.

Considering our American heritage and tradition, it is unfortunate that the urban public is increasingly restricted in its opportunities to hunt and fish. Primarily, it is a population problem. Many of you don't understand that there simply isn't room for all of you outdoors any more. It is hard to realize that urban development is swallowing a million acres of these United States every year. I can't afford to open my gates to the public because there are too many of you, my investment is too great to jeopardize, and I can't trust you to respect my property. I could recite numerous instances of destruction and vandalism which I am sure no one in this audience would ever commit, but which happened nevertheless. My land is posted and my gates are padlocked because I have to protect my property as best I can.

I have tried to show that a ranch is a business enterprise; it is also a home. Suppose the customary situation were reversed, and two or three ranch hands should happen to come to your town, to your factory, your store, or your office. Assume they are carrying guns and a bottle of whisky, and ask for a place to have a little target practice. Suppose they come to your home and want to have a picnic in your front yard or camp in your spare bedroom. Would you allow strangers, obviously out for a big time, to intrude on your privacy? Would you open your place of business or your home to the public, especially without constant supervision and personal observation? Neither will I, and whether or not they happen to have some kind of a license will not make any difference.

At this point, if you have any mental reservations about my commercialistic attitude toward the great outdoors, I challenge you to repudiate the support of the people who manufacture and sell guns and fishing tackle and camping equipment, as well as the restaurants and motels and filling stations and Chamber of Commerce in the towns where you go to hunt and fish. If it is wrong for ranchers to try to make money out of natural resources, let's look at some of the people who are furnishing financial and political support to the wildlife organizations and examine their motives. I can cite an example in my home county, where there has been agitation for years to dam the North Canadian River—a project which both the Corps of Engineers and the Bureau of Reclamation have rejected as not justified either for flood control or irrigation. This project would bury forever some of the most productive hay and grazing land in the county, and require the relocation of highways and bridges, not to mention the abandonment of several ranches. Yet pressure has been exerted by interests which are willing to waste a good many million dollars of public funds in order to promote a recreational area for their own personal profit.

I suggest that we as conscientious American citizens adopt the following principles as the basis of a national policy for the preservation of natural resources:

1. Accept as a definition of conservation the formula proposed by Hugh Hammond Bennett: the use of land according to its capabilities and treatment according to its needs.

2. Recognize that the public welfare is paramount to the selfish inclinations of any class or group.

3. Respect the human and property rights of the individual citizen.

I am frank to confess that there are still some ranchers who are not in full agreement with these principles. You who represent the great force of public opinion can help to secure a broader acceptance. While I assume that this audience is not interested in technical details, I think you realize the importance of range conservation as related to erosion control, water resources, and food for wildlife. Aside from the public interest, range improvement is as essential to the livestock industry as herd improvements, and is so recognized by progressive ranchers.

To you who find your access to the great outdoors becoming more and more restricted, I suggest that most of your difficulties with landowners are caused by the ignorant and careless minority of "sportsmen." Although I think your activities in future years will be largely limited to private preserves on some sort of a lease or fee basis, I am confident that your public relations will be greatly improved if you will assume more responsibility for the education and good conduct of your followers.

DISCUSSION

VICE CHAIRMAN STANLEY B. MULIAK: This, indeed, is a very challenging discussion, and it reminds me that maybe we are not doing as good a job as we should.

MR. ATKINS: Mr. Chairman, that finishes my script. If I have a little time left I might give you another incident.

In the last paragraph I referred to public relations. Out in the panhandle of Oklahoma where I lived some years ago the State Fish and Game Department started distributing pheasants and quail.

The landowners were glad to have them. Nothing was ever said about anybody hunting them.

The pheasants did pretty well, and some years later the fish and game department decreed a 3-day open pheasant season. There was a lot of publicity in the papers, and the landowners in the panhandle read the papers, too. Up went the posting signs. The hunters had paid for their licenses. They were informed that there were pheasants to hunt. When they came out, all they saw was "no hunting" signs. They were unhappy, and the landowners were unhappy. Things got to the point in at least one instance I know of where the hunters went in on posted land, and when the landowners attempted to evict them, they actually threatened him with their guns, and he had to get the sheriff to get rid of them.

I don't know how much ill will was generated by that incident. I will say that the Fish and Game Department has improved its public relations since that time, but that is an instance in which two divergent groups clashed through lack of understanding. The hunters had reasonable expectations of hunting; the landowners still felt they should protect their property.

MR. LES BERNER [PIERRE, S.D.]: I voted for the last speaker in the Range Society. He is a good man. One of the principles he asked us to accept was that we should use land according to its capabilities and treat it according to its needs. Well, I come from an area where they are doing a lot of draining. A lot of that soil is capable of producing additional bushels of wheat. Now there is a capability. Do you therefore advocate drainage of these acres?

MR. ATKINS: In the area in which I live we don't worry about drainage. We are in an 18-inch rain belt, and we want more water. I am not familiar with the problems of drainage. If you are referring, as I think you are, to marsh lands which are now wildlife refuge and so forth and refer to draining them in order to produce food, well, I think that would have to be a decision as to the public welfare. Do we need the food worse than we need something else? What contributions would these marsh lands make to our water resources?

I don't live in one of those areas, so I don't think I could answer categorically. From what I do know of them, I would say that draining those marsh lands certainly brings about some conservation problems, and I think there have been some areas drained that should not be, but I am not familiar enough with that individual problem to provide an answer.

MR. C. R. GUTERMUTH: I am the man referred to in the paper. I would like to say at the outset that it's my job to try to put on these conferences, and in all the many years that I have had anything to do with these conferences only once before did I open my mouth in one of these meetings. I am doing it again at this time only because I have been named specifically and only because the distinguished speaker referred to me directly. He said that in my talk in 1956 in Denver I used that opportunity to deliver a blanket indictment against ranchers, the general theme being that they are a blind, greedy group of monopolists who are plotting against everything that is for the public good.

Now my only purpose in standing up here is to set the record straight. I think I have been a dues-paying member of the American Society of Range Management about as long as Mr. Atkins and I probably voted for him for president of the A.S.R.M. I think that I have as deep respect and admiration for ranchers as Mr. Atkins and some of my best friends of many, many years' standing are ranchers and people that I love and know well. Never let it be said that I have ever condemned ranchers in a general way in my life. If I ever have, I now apologize for any such blanket indictment.

My paper presented at the Denver meeting of the American Society of Range Management was multilithed and distributed. You can get copies of it, and I think you will find that it indicates that my only concern about ranchers is that upon several different occasions within my time in conservation work they have permitted a small clique among them to attempt in one way or another to gain control of the public lands of this country for grazing purposes. When those occasions have happened, I have been one of the strongest opponents of attempts to get that land into one single use or to weaken or remove public control and management, and if such attempts are ever made again, you will find me in the forefront in trying to rebuff those selfish efforts.

We had attempts first where that small clique of ranchers has tried to gain control of National Forest lands, first by purchase on a long-term, small price basis; and we have had attempts to gain control in other ways.

I said in my Denver talk, and this is well documented, that we realized then, and we realize now, that that is not the thing that has been advocated by the vast majority of ranchers and land managers of this country. Those efforts were perpetrated and attempted and tried by a small clique within the ranching industry, and my condemnation then and now is that this great industry, and my good friends in the ranching industry, permitted a small clique to try to take over the management and domination and control of the Federal lands of this country. I fought it then and I will fight it again if new attempts are made. I just want to correct the record.

MR. ATKINS: The incident which I referred to happened some four years ago, and as I said, I intended to use that as an illustration that appeared to be typical of some of the people in the wildlife organizations. If Mr. Gutermuth held the view which I interpreted, that certainly is his right as an American citizen. I will say this, that my impression of his talk was shared by others who were present at the same meeting. If I misinterpreted his remarks, I am sorry, but I was not alone in that interpretation. It was not made clear to many of us that he was distinguishing between this small group, which he mentions and which I will freely acknowledge exists, but we interpreted it, I and many others at the meeting, as applying to the broad group of ranchers in general.

MR. JEWELL CALLAHAM [Oklahoma Wildlife Commission]: I am a member of the Oklahoma Wildlife Commission. I haven't had the pleasure of meeting Mr. Atkins personally. I certainly want to have the pleasure of meeting him and getting a little further expression of his statement of his fellow ranchers' thinking in northwestern Oklahoma. From where I live to where Mr. Atkins lives is about five or six hundred miles. There is a lot of difference in our part of the state and his part of the state. I am not acquainted with all of the problems out in the northwest part of the state. However, I will say this that in the southeast part of Oklahoma that the sportsmen of Oklahoma respect their fellowman's land. The wildlife department for a number of years, and especially now, is trying to work with the sportsmen and with the landowners, to create better feeling and mutual understanding and respect.

I think we have perhaps one of the greatest sportsmen's organizations in the entire nation in Oklahoma.

MR. ATKINS: In my recalling of this incident, I said the fish and wildlife agency in Oklahoma had improved its public relations. Certainly I realize that with the limited number of people they have in their organization they are tremendously handicapped, and the circumstances I referred to have improved. Again I was trying to get the idea across of the importance of public relations.

I would agree that the antagonism in that particular circumstance that I cited could not have been completely avoided. I think there should have been better understanding created in advance that the pheasants were being put out to be available for public hunting, and that they were paid for with public funds. I certainly agree that the hunters had a right to expect that they could hunt them, but there again you have the difficulty of the landowners and their attitude. I am not saying that the landowner's attitude is in all respects correct, but you have a difference in their interests as opposed to those of the sportsman's organizations.

As I said, if you leave out the public lands, with as many people as there are in urban areas, I think hunting is just going to be limited more or less to private preserves on some sort of a lease and fee basis. It's unfortunate that a good many people just aren't going to have the opportunity to hunt and fish.

VICE CHAIRMAN MULAIK: I think the key to the problem here comes down to a matter of public relations, and it can be said without any argument that what is needed is a getting together of people on what appears to be the two sides of this resource problem. I don't think we can carry this to a conclusion here, but you people at the local level will have an opportunity, I think, and a charge, too, to do something to clarify this apparent difference. Thank you very much, Mr. Atkins.

TREE FARMING PAYS OFF

E. R. WAGONER

Executive Secretary, Texas Forestry Association, Lufkin, Texas

"In these times of mushrooming population, when the demand for outdoor space and wood products are increasing steadily, it is highly important that all segments of the American public understand the relationship between timber and wildlife." So stated Ernest Swift, executive director, National Wildlife Federation.

Authorities predict that by 1975, pulpwood consumption is expected to double, plywood and veneer is expected to nearly double, and lumber consumption is expected to increase approximately 10 per cent. Another startling statistic is the increasing amount of paper that you and I use. In 1939, we used 244 pounds per capita. Today we use 425 pounds per capita. By 1965, we are expected to be using 495 pounds per capita.

Few, if any, forest industries in the South can sustain themselves completely from their own forest lands. They are all dependent on the timber crops of the small landowner. In the South, industries own about 7 per cent of the forest land, but the small landowner accounts for almost 75 per cent of all the timberland.

Nationally, these little forests, averaging 62 acres each, make up 57 per cent of the commercial forest land of the United States and 75 per cent of all of our private commercial forest area. They provide a large part of the raw material for our forest industry; for example, they furnish 70 per cent of all pulpwood to the South's growing pulp and paper industry. In many communities, they are the only source of supply for small, but important, wood-using plants.

On January 1, 1960, there were 16,740 certified tree farms in the Nation containing 51,342,000 acres. Most of these tree farmers are small woodland owners. The American Tree Farm System is sponsored nationally by the American Forest Products Industries, Inc. and operated at the state level under local sponsorship. The tree farm program began in the State of Washington in 1941, and has spread to 47 states.

Tree farmers are landowners who manage their woodlands to produce maximum income. The words tree farm, when applied to a piece of privately-owned, tax-paying, forest land, mean the landowner has been publicly recognized for doing an outstanding job in managing his woodlands for the continuing growth of forest crops for commercial purposes.

Trees are a crop. Although tree crops do not require intensive cultivation, there are certain practices that must be done to keep their growth rate and quality high. The following practices are the basic requirements for a tree farm, but vary slightly from state to state: 1. Protect your woodland from wildfire, insects, disease and overgrazing; 2. harvest your trees when mature or ready for thinning; and 3. plant trees on idle acres.

The term tree farm is synonymous with forest management. In fact, tree farming is both a means toward progress and evidence of progress itself. The management practices utilized by these tree farmers reflect enlightened self-interest because tree farming involves no subsidization or tax concessions. It is a voluntary, on-the-ground example of our national incentive system of business in operation.

We often hear the comment, "Timber won't do me any good; it might help my grandchildren." Ladies and gentlemen, this concept is out of date in the South. The longest period with no income is the 12 to 15 years from the seedling to the first pulpwood cut. Income can then be expected from the same acre every five or six years.

Timber may be compared to a bank savings account. The trees are the capital or principal. The new growth is interest. Each day the interest is added. If the woods are overcut, the principal is depleted and a lesser amount of interest is realized. Tree farming is a good investment. Because trees grow, a well managed woodland will provide steady income. Cash from timber crops may help finance a college education or provide retirement income.

Tree farming does pay. Progress in tree farming means progress in related fields, but most directly affected are sportsmen, picnickers, campers, and everyone who needs clean, potable water. Although most of the nation's timberland is best suited for growing timber, timber production automatically involves other related benefits—wildlife, recreation, soil stability, and watershed improvement. Tree farming creates and continues a good cover for the soil; this, in turn, has beneficial effects in reducing runoff and maintaining stream flow. Tree farms hold water like a sponge, releasing it gradually, which helps to stabilize stream flow.

What are the business aspects of these small forest ownerships to the community, the state and the nation? Certainly, we in the South are anxious to provide more job opportunities for our people, to improve our overall economy and tax-gathering structure by stabilizing industrial expansion; we are all anxious to improve the standard of living of our people, and to create new wealth in raw material sources to bring about these changes. Certainly the public needs to be continually reminded of the contribution these little forests and the industries they supply are making now—and the tremendous import they can hold for the future if properly managed.

What are the business aspects of these small ownerships to the forest industry? Most industries desire expansion of their operations, and certainly all desire stability at present levels of production. With corporate forest ownership fast reaching maximum production, it must turn to small woodlands for a large part of any expanded forest industrial activity. Forest industry is proud of its part in the total picture as sponsor of the tree farm programs, as provider of markets for products produced by the small woodland owner, and for its program of research in developing new products, better utilization, new uses for wood, and its educational and technical assistance programs.

In extending the concept of tree farming beyond the boundaries of their own forest land, some individual forest industries have adopted a "family" approach. In a tree farm family, the company serves as a "parent" in helping individual forest owners achieve a profitable level of forest management.

This approach to forest production has been successful because it directly attacks basic problems. Many small landowners lack the know-how of forest management. Often, too, they lack the skills and equipment necessary to establish, protect, manage, and harvest their timber crops. On the other hand, the forest industries want to assure themselves of a continuous supply of raw material. Under the tree farm family approach, forest management services are provided by the company at no cost or obligation to the forest owner and the family member is given first consideration in the purchase of wood for the company plant, plus assistance in marketing materials the company cannot use. In return, the company is given first opportunity to buy timber at going prices when it is offered for sale by members of the family.

As the mutual benefits of such a relationship between forest owners and forest industries became evident, the family concept spread through several states. More than 20 individual wood-using companies now support tree farm families and the program is expanding steadily. This is cooperation which does credit to our nation's business system. It has opened another avenue of progress and promises more results in the future.

In spite of the obvious value of the tree farm program, however, we do not have enough tree farms. Many woodland owners are not managing their timberlands in a manner that will assure a continuous crop of forest products. These areas cannot qualify as certified tree farms. To help combat this problem, the American Forest Products Industries has developed a Busy Acres Program. The program was launched recently in North Carolina, Florida, and Mississippi. It will be launched in other states, including Texas, within the next few months. It is designed to assure further progress in tree farming and the expansion of the Tree Farm System.

Many owners are not aware of the potential productivity of their idle or lazy lands and the income that could be had by applying forest management principles. As a result, vast areas in the United States are lying idle, producing no income for the owners and no forest products of value to the nation. These areas are well suited to the production of tree crops. There are also millions of acres of timberland that can be classified as "lazy"—loafing acres, producing at only a fraction of their potential rate. Tree crops on this lazy land are in need of cultural improvements if they are to contribute fully to the nation's timber production.

As forest owners accept the fact that timber is a crop and become interested in good management, there comes a time when they must find out how to do the job. To supply the necessary owner-education in this respect is the task of the Busy Acres Program. The local forest industries, believing that responsibility for unproductive land belongs to forest owners, recognize that more is needed than just talk. They realize that owners who become interested in forest improvement must be provided with technical "know-how" before that interest can be translated into action.

Busy Acres does three things. First, the forest owner is made aware of the importance and potential benefits of tree farming to his own economic situation. Next he is provided with the basic knowledge required to do the job. Finally, provision is made to supply personal forestry assistance to owners in need of it, so that their idle or lazy acres can qualify eventually for tree farm certification.

Busy Acres is almost entirely educational in nature. Sponsored by local forest industries, it is a statewide program enjoying the support and encouragement of all forestry agencies and associations in the state. Busy Acres is an elementary practical course in tree farming. It helps an owner take the important first steps in establishing the improved levels of forest practices required for tree farm certification. Here is industry's response to the nation's small-owner opportunity in forestry—a private incentive program designed to make certain that no landowner with idle or partly productive forest land need go without forestry information, advice or assistance.

Tree farming, the growing of timber as a crop, is a good way to put to work thousands of acres of abandoned farm lands in the South that were formerly devoted to growing row crops, such as cotton. No longer can we refer to "King Cotton" in the South. Timber—not cotton—is now the leading crop in the South. Income from timber in the ten states of the deep South exceeds the cash receipts from other farm crops.

A tree farmer harvests his tree crop at his own convenience. A tree does not have to be harvested in a particular week, month or year. Trees can be sold when the market is right—when it is most profitable.

Many tree farmers grow timber for their own use. Fence posts and timber for barn and house repairs are always in demand.

The question is often asked, "Why should I be a tree farmer?" "What do I get out of it?" Well, if a man is looking for special tax concessions or subsidies, the answer is "nothing." If, on the other hand, he wants to make his woodlands provide maximum and steady cash returns, the answer is "plenty." A tree farmer knows that his land is not only helping him, but is providing jobs for his community. Every 80 acres in full timber production means a job for one more man. With that will also come better protection from erosion, reduction of silting in expensive reservoirs, additional raw material for local industries which means more payrolls, better habitat for game and fish, and public recognition for the owner which will establish him as an outstanding citizen interested in improving the welfare and economy of his community. Above all, a tree farmer receives the satisfaction of a job well done. A tree farmer is a living example to his neighbors who will probably follow his example.

Fortunately, we can have both timber and game from the same lands so long as there is public cooperation and understanding. Well managed tree farms are a sportsman's paradise. Well planned management of our timberlands means several things of special interest to sportsmen. First, good management of timberlands usually assures a high level of production of both wood and game, and second, it offers an excellent prospect for sustained yields of both timber and game as twin crops. Tree farming not only provides food and shelter for wildlife, but it also protects their forest home from fire.

The tree farm program undoubtedly was an important contributing factor in bringing the nation's forest growth into balance with removal. It helps provide assurance that the United States, through private initiative, will continue to enjoy an adequate supply of wood products and related benefits in the future. With the full backing of forest industries, tree farming and tree farmers will exert an increasingly important influence upon the nation's forest economy. Yes, tree farming does pay off.

DISCUSSION

VICE CHAIRMAN MULAIK: Mr. Wagoner presented some very significant viewpoints. It made me think of that Monday morning trip 52 times a year down to a curb with a great big trash barrel that must carry a load of anywhere from 20 to 30 or 40 pounds, almost exclusively paper, and at that rate I think the 400 pounds is way low for my use of paper. That's an interesting thing. It had never occurred to me, but that certainly is a point. How many trees does that 450 pounds represent?

MR. WAGONER: Naturally the larger the tree the more paper you can get from it. Here in the South we make paper from the smaller trees and from the tops of the trees which are cut for saw logs and poles and piling and other products of that type. We try to encourage the tree farmer to put each tree into the product which will bring him the most income.

I have answered the question in a general way without giving you a definite answer because as I say, the larger the tree the more paper you are going to get. Now we do also use other large trees in the pulp and paper industry. If you have a tree which is crooked that will not be suitable for a sawlog, it might have quite a large diameter. It, too, can be used in paper.

Someone asked me a question last evening that I might answer now. They were quite surprised at these percentages of paper that I quoted, and they asked me how much of our paper is produced in domestic mills. The answer from estimates would be roughly 75 to 80 per cent of our paper is produced within our nation. Thank you.

VICE CHAIRMAN MULIAK: An interesting point that was made was that 80 acres added to tree farming provides the income for an additional man. That is very significant when you figure that on the basis of an acre that is thirty or so dollars an acre. A little less, a little more, it depends on what you figure as the base pay. These are interesting figures that were presented.

CHAIRMAN ZIMMERMAN: I would just like to review with you for one moment the theme of the morning conference in which we undertake to relate our interests in conservation to individual needs. We say that conservation is most meaningful in terms of satisfying the needs and aspirations of individuals. Certainly our interests are different as represented on the panel this morning. Mr. Lowery is concerned lest we cover too much of the good farmland of the country with asphalt and housing developments, so that we block out too much of the Class 1 foods and fiber producing land of the country for nonproductive food uses. Red Atkins was very much concerned from his point of view about the invasion of the property rights to personal privacy, and we find, too, from Mr. Wagoner's report this morning that we do have those landowners and land users who hold large tracts of land best suited probably for the production of trees. Even so, there is probably no area of resource use that has a wider diversity of interest than the use of these resources for recreation. I am sure that Henry Clepper's interest in conservation as a matter of recreation will be different from those of Ed Graham or Charlie Stoddard. I suppose there are just as many different variations as we have persons here this morning. Nevertheless, to each one these recreational needs are very real.

As we hear from the next speaker I do hope that you will recognize that this is one person's view, and that he is a typical user and thinker about the use of our natural resources in a conservation way and attempt to translate in your own mind your own feelings about resources and what they mean to you from a recreational standpoint.

HOW CONSERVATION MEETS MY RECREATIONAL NEEDS

Norman Kraeft

Farm Service Director, WGN, Inc., Chicago, Illinois

When Gordon Zimmerman asked me to speak on the topic, "How Conservation Serves my Recreational Needs," I was sure his sense of humor had taken a turn for the worse. Gordon knows that I, quite frankly, am not the outdoor type. In all honesty, I have never gone hunting in my life, and I can only recall two occasions on which I have gone fishing . . . both times under strong protest. Now, Gordon knows this. Basically, he is a serious person. There must have been a method in his apparent madness. The more I thought about his invitation, the clearer that method became.

Gordon knows that I have developed a profound respect for the importance of conserving our soil and water resources. He knows this, because of what I have learned at many conventions of state and national associations of soil conservation districts where he and I have had long and—to me—profitable visits.

What he doesn't know—but, I'm sure, suspected—is that I started learning about the importance of conservation to recreation more than thirty years ago. On Saturday mornings our gang took forays into what is still known as the Forest Preserve, wooded areas designed for hiking and picnicking, areas that dot the fringes of Chicago's suburbs. Although I didn't realize it at the time, I do remember now that a basic principle of conservation—reforestation—made an indelible impression on my mind. It was fun to hike through those woods. Walking down a leaf-strewn path, bordered by trees—big trees—little trees—was an experience that furnished an inner satisfaction that only the poets, at their inspirational best, can put into words. And they succeed only in part. Remember, I said "big trees, little trees."

The littlest of them were mere shoots. And I think now we are getting close to the secret of the satisfaction of walking in the woods. I was a small boy then, and I was a long way from beginning to grapple with the complexities of reproduction. But I think the satisfaction I felt then had much to do with a realization that was perhaps not much more than intuitive. I realized, I am sure, for the first time, the wonder of nature reproducing her kind. Yes, I am sure that is right, because as it comes back to me now, I was impressed with the rugged, jagged giants of trees, dead or dying, and beside them, the tender shoots of the same species, green . . . and very much alive. Nature reproducing her kind. And, thus, my first lesson in conservation. Today, those Forest Preserves still stand, quietly teaching another generation of youngsters their first lesson in conservation. The thought occurs that this dissertation might well explore the close relationship between the words "conservation" and "recreation." Does not conservation have to do with re-creation?

I live and work in Chicago. As a matter of fact I live on the 24th floor of an apartment building less than two miles north of Chicago's downtown section. Of what possible concern to me and the other cliff-dwellers in Chicago are the relationships between conservation and recreation? Well, I invite you to join me—or any of us—as we pack the family into the car on a hot Sunday in July and head for an outing in the Indiana Dunes, some 50 miles away. I guess we Chicagoans are interested in some form of outdoor recreation, judging from the solid jam of cars on the Indiana Toll Road that I have seen extend for 15 or 20 miles, as we wend our way back into Chicago after a day in the country. Perhaps, for most of us Chicagoans, the word "conservation" isn't worth even a pause in our day's occupation, but we apparently enjoy the fruits of conservation, judging from the fact that on a typical Sunday in mid-summer the "world's busiest corner," State and Madison in Chicago's loop, is practically deserted, while nearly every nook and cranny of the Indiana Dunes become a "State and Madison." You are familiar, I am sure, with the headlines that have been created in recent years by the threat of heavy industry taking over the Dunes area. Yes, conservation serves the recreation need of the nation's second largest city.

Speaking of the Dunes, I lived in the Dunes area for about eight years, and during the winter of one of those years—I think it was five or six years ago—I saw Lake Michigan literally swallow up large chunks of those Dunes. The lake rose . . . and as it did, it virtually eliminated the beach. But it didn't stop there. It kept rising and, as it did, it knifed into the Dunes. I saw hundreds, if not thousands, of trees topple into the lake. Retaining walls retained nothing. They themselves toppled into the lake. Hundreds of homes along the lake shore were threatened. Rooms fell off of these homes. In one case a grand piano, along with other pieces of furniture, toppled into the lake. I cannot give you a technical explanation of how these things could have been prevented, but I am sure that I could have collected a goodly number of votes from lake shore property owners at the time for a plan that could have prevented the destruction of property suffered by these people.

I have already admitted that I am not the outdoor type. I readily admit also that I am in the vast minority among my friends and acquaintances in this regard. Most of my associates are enthusiastic hunters and/or fishermen. Some of them are aware of the great debt they owe to cooperators in Soil Conservation Districts across the length and breadth of our land; most of them, I am sure, are not. In the words of A. E. Borell, SCS biologist in Denver, Colorado, "Soil Conservation Districts have sponsored conservation practices such as stripcropping, contour cultivation, proper irrigation, crop rotations, stubble mulching, grassed waterways, improved pastures, range management, farm and ranch ponds, windbreaks, and other erosion-control measures. These practices have slowed erosion, increased the quality and quantity of plant growth, and thus the ability of millions of acres to support more people and more wildlife." In 1957, when Mr. Borell wrote these words, there were over 2,750 Soil Conservation Districts in the United States. In these districts more than three million acres of trees had been planted; more than 26 million acres of pasture and range had been seeded; more than three million acres had had wildlife practices applied; and more than 800,000 ponds had been built. Of course, these figures are much higher now. Mr. Borell points out other conservation practices which have resulted in a refurbishing of our fish and wildlife resources. The cutting of dense stands of timber had permitted the growth of grasses, forbs and shrubs. This increased the carrying capacity for deer, elk, grouse, furbearers and many others. The construction by farmers and ranchers of thousands of reservoirs, lakes, ponds, ditches and windmills has put water on millions of acres where previously water was the limiting factor for wildlife. These man-made ponds provide water for big game, fur-bearers, upland game birds and, in addition to providing drinking water and resting places for migrating waterfowl, many of them produce one or more broods of ducks each year.

Wheat, corn, milo, rice, pasture grasses and legumes, and other farm crops produce high quality wildlife foods in quantities far beyond that produced by the original grasslands, forests and deserts. It is obvious, says Mr. Borell, that pheasants could not have lived in most of the United States prior to the planting of agricultural crops. It is true that large areas of land were cleared and thus many acres of wildlife cover were destroyed. In their place, though, we have thousands of miles of fence rows, windbreaks, shelterbelts, ditchbanks, drainage canal banks, roadsides, grassed waterways, and terraces that provide cover and travel lanes for upland game. Although in many areas there is a smaller total acreage of cover today than 50 years ago, there is more food for many species and far better distribution of cover, in relation to food and water, and, thus, a higher carrying capacity for most kinds of wildlife.

Let's look for a moment at some of the ways that windbreaks can serve to protect and encourage the maintenance and multiplication of wildlife. The trees and shrubs used for windbreaks make valuable cover and nesting areas for upland game and songbirds. They make homes close to cropland for insect-eating birds. Right here in Texas, a half-mile field windbreak examined by biologists had 25 occupied bird nests and was sheltering a covey of quail. The biologists estimated that this bird population would destroy about 260 pounds of insects during one year. Pheasants, grouse, quail, partridge and doves use windbreaks for cover, food and nesting. Winter, of course, is a critical period for non-migratory birds, and any protective shelter adds to their chances for survival and increase. Windbreaks protect game-birds against cold, driving rains and blizzards. When all other food is blanketed with snow, tree and shrub seeds and fruits provide welcome food. According to the Soil Conservation Service, a windbreak—to be of greatest value to wildlife—should include at least one or more rows of dense, low-growing shrubs or coniferous evergreens, or both. Where blizzards are common, the windbreak must be wide enough and the species so arranged as to prevent complete filling with snow. The SCS recommendation is that certain kinds of shrubs and trees are better than others for wildlife. Low-branching evergreens are excellent. Other good species include autumn-olive, Russian-olive, aromatic sumac or skunkbush, buffaloberry, wild plum, honeysuckle, hawthorn, privet, chokecherry, and, in parts of the country where it is hardy, multiflora rose.

It may be useful here to review the steps taken by the Soil Conservation Service to help assure wildlife a lasting place on the American scene.

1) SCS supports State and Federal wildlife agencies in their programs to create and improve wildlife habitats. Important to our waterfowl resources are the opportunities for public acquisition and leasing of key marshlands in the prairie duck-breeding area to be used as breeding grounds.

2) SCS provides land-capability information and technical assistance to land owners and operators to help them concentrate crop production on land best suited to cultivation, and to keep other land in appropriate vegetation or water areas.

3) SCS informs farmers and ranchers of the values of the wildlife resource in its many forms and encourages them to provide for its various habitat needs.

4) SCS provides technical services to farmers and ranchers in improving wildlife habitat on agricultural land as well as on special areas devoted primarily to wildlife use.

5) SCS assists with the creation of new bodies of water valuable to wildlife through construction of ponds, dugouts, and reservoirs on farms and ranches and in small watershed projects.

6) SCS employs specialists trained in wildlife biology to assist with work affecting wildlife in all soil conservation districts.

Point 5 above referred to "small watershed projects." Perhaps not all those interested in fish and wildlife are familiar with the fact that works of improvement for non-agricultural water management may be included in watershed work plans providing for the protection and improvement of the interrelated land and water resources of the watershed. Included are works of improvement for fish and wildlife development such as storage capacity in reservoirs for fish and wildlife development; modification of reservoir structures for fish and wildlife; stream-channel improvement for fish and wildlife development; and marsh and pit development, including facilities such as fencing, to provide breeding and nesting areas for migratory waterfowl and aquatic mammals.

The foregoing is a spelling-out of the fact that under Public Law 566, "The Watershed Protection and Flood Prevention Act," as amended, the Secretary of Agriculture is authorized to give technical, cost-sharing, and credit aid to local organizations in planning and carrying out works of improvement for "nonagricultural water management, including municipal or industrial water supply and fish and wildlife development." This is Point 3 under the Act. Points 1 and 2 have to do with works of improvement for flood prevention and agricultural water management.

Before leaving the subject of watersheds, may I be excused for making as strong a plea as possible to all of you, particularly those of you who have access to any of the communications media. I feel sure that there is little doubt in any of our minds that small watershed projects will contribute a great deal to the development of our fish and wildlife resources. If this is important to us, let's tell it from the mountain, to be sure, but let's tell it in town as well. And let's tell it as effectively as possible. It is my firm conviction that, in Chicago, for example, most people have no idea whatsoever as to what a watershed is. They are not even familiar with the fact that they live in one. Is it any wonder, then, that our state legislature in Springfield, Illinois, makes not one penny of cost-sharing aid available for small watershed programs in our state? Before action must come understanding, and I think the general lack of understanding about watersheds is a major deterrent to adequate progress in this important field. Let us use our newspapers, magazines, radio and television stations to spread information to the general public about the importance of watersheds to all of us. As one engaged in radio and television work, I would like to say that in more cases than not you will receive a cordial reception from the program manager of your local radio or television station if you take the time to pay him a visit and suggest that he program an interview or a film on the subject of watersheds. But, please heed this warning. This man, through no fault of his own, may know absolutely nothing about watersheds. Don't try to sell him on running a watershed feature without first making sure that he knows what you are talking about. If, at first, you don't succeed, don't give up. Remember, this man is approached every day in the week by representatives of a host of special interests, some of them of public service value, some of them of little, if any, discernible value to anyone. And—may I suggest an opening for your interview with your local radio or TV program director? It's the first sentence in SCS Pamphlet 392 on "Small Watershed Projects." "Wherever you live, you are within a watershed." If you can't take it from there and do an effective selling job, I have misplaced my confidence in you! Also, the fact that there are thousands of hunters and fishermen who live in the city should help your cause.

Now, even though my enthusiasms, as stated, lie elsewhere than in hunting and fishing, these forms of recreation are dependent in large measure on conservation practices of many kinds, and perhaps it would not be amiss to review some of them here. Let's look at these conservation practices in terms of what they mean to sportsmen. Intelligent hunters look for conservation farms and ranches. Soil conservation practices give important tip-offs on where good hunting and fishing can be found. Most farmers are friendly to considerate sportsmen. Borders planted or cut out along wood's edges by conservation-minded farmers provide homes for quail, rabbits, rugged grouse, and pheasants. A word of appreciation to the farmer from the considerate sportsman costs nothing . . . and can pay big dividends. Windbreaks, as pointed out previously, not only prevent soil from blowing, protect buildings, and provide winter food and shelter for game. They also tip off sportsmen to good hunting. It's a good idea to get acquainted with conservation farmers before hunting their land. Many farmers devote fence rows, abandoned roads and other such odd areas to wildlife. They plant them to trees and shrubs that provide wildlife food and cover. Friendly relations with the farmer help repay him for these efforts. Irrigation reservoirs and flood-prevention dams furnish stopover spots for thousands of migrating ducks and geese. These stored waters are part of a nationwide program of soil and water conservation. They provide good fishing, too. Two million farm ponds built by farmers for soil and water conservation have improved duck production and duck hunting throughout the United States. Remember, it's courteous to stop by the farmhouse and get permission to hunt and fish. Stripcropping usually is a sign of good hunting in pheasant country. This soil conserving practice furnishes gamefood and shelter. Be careful not to shoot toward buildings, livestock, or field workers. Many wet spots on farms are managed for fur-bearers and waterfowl as part of farm conservation work. Why not get your sportsmen's club to study the wildlife work of your soil conservation district . . . and lend a hand? Woodlands protected by soil and water conservation practices support deer, grouse, squirrels, and other wildlife. Be careful when you are in the farmer's woods—fire destroys wildlife, as well as trees! Grassed waterways tip you off to silt-free streams. The grassy edges make nesting places for quail and pheasants. Leave fences standing and gates as you find them. "Living fences" are a sign of the conservation farmer. They are a sign for the rabbit hunter, too. Living fences provide travel lanes and wildlife shelter and food. Stubble mulches and crop residues, conserved by farmers, furnish the seeds and waste grains that are choice foods of mourning doves. Observing rules of good sportsmanship opens many posted acres to hunters. The better grass cover on improved rangelands furnishes homes for prairie chickens and other grassland game. The better water supplies furnish water for game birds and animals as well as for livestock.

It is generally conceded that the conservation practices which have picked up steam in recent years are in large measure responsible for the fact that, although some wildlife species have become extinct, many species of game are actually on the increase. Hunters in the prairie states today find doves, deer and squirrels in numbers seldom seen by early explorers. Ring-necked pheasants probably exceed the original number of prairie chickens and sharptailed grouse. Songbirds, fur animals, fish, and other species have also increased. These changes in animal life are largely the products of modern land use patterns that did not exist in the primeval prairie. This isn't a completely rosy picture, of course, because although upland wildlife has prospered, the fate of waterfowl has not been so happy. The advance of intensive cultivation dried up some of the nesting areas, unrestrained hunting in the early days decimated much breeding stock. That trend has been arrested and even reversed in the past quarter century, but sportsmen and other conservationists are still concerned over the uncertain waterfowl supply. There is encouragement in the fact that farmers following conservation plans in the waterfowl-producing areas by July, 1959, had improved about 178,000 acres of habitat which they had planned on their own farms to be used especially for wildlife. Permanent wetlands unsuitable for cultivation have been improved by hundreds of land owners for waterfowl, upland game and furbearers by such practices as regulating water levels to produce food and cover, controlling excess marsh vegetation, providing loafing spots for ducks, controlling fire and grazing, seeding intermittent wet spots in fields to water-tolerant grass, and constructing level water-access areas in marshes. The Soil Conservation Service reports that as of July, 1959, soil conservation district cooperators had completed conservation practices beneficial to wildlife in the waterfowl-producing area in the following amounts: 151,000 acres of tree planting; 305,000 acres in contour farming; 6,709,000 acres of conservation crop rotations; 2,178,000 acres of stripcropping; 9,511,000 acres of stubble-mulching and crop-residue protection; 3,979,000 acres of properly used range; 797,000 acres of pasture and range seeding; 1,017 miles of terraces and diversions; 22,000 acres of grassed waterways; and 21,000 ponds and dugouts. A great deal has been done, but the job is far from finished, especially in view of our accelerating population growth rate . . . and all that that implies.

In closing, I want to touch on a point that seems highly significant to me, a person who is not a hunting or fishing enthusiast, but one who believes deeply in the importance of soil and water conservation to all of us. I, and my fellow Chicagoans, enjoy the fruits of conservation, whether we know it or not. We like to walk in the woods; we like to drive through the countryside on a Sunday afternoon. We look forward to an outing in the Indiana Dunes. Some of us realize, others do not, that the practices of soil and water conservation increase the beauty and enjoyment of these experiences manyfold. I have been told many times that a good farmer is one who cares for his soil just about as carefully as he cares for his soul. It is more natural than most city folks think that conservation farmers observe a "Soil Stewardship Sunday." Conservation will serve the recreational needs of Americans even better than it does now when we—

who know the importance of conservation—succeed in selling our city cousins also on its importance. Let's get to work.

DISCUSSION

MR. SETH MYERS [Pennsylvania]: I am the secretary of the Outdoor Writers Association of America, and in two papers presented here this morning there have been indications of a lack of common knowledge between two factions of American citizens. I would like to comment that after many years of the outdoor writers which includes the press, magazines, radio, television, public speaking and various people whose duties are to disseminate information to the general public, we have not yet been able to reach a certain goal.

A paper was presented here by a gentleman, a rancher, directing some criticism perhaps at the Oklahoma Conservation Department. Then from the chair there were some comments made that heaped coals on the fire slightly because here was a situation where the landowners were not familiar with what the conservation department was doing, and who was to blame?

I am quite familiar with the public relations department of Oklahoma. They do a tremendous job of preparing materials with which to keep their entire state informed. I am also quite familiar with the problems of the landowners, and here somewhere is a lack of cooperation which I believe the press of Oklahoma, the newspapers, radio, failed to familiarize the people in advance with this problem that developed later.

Our most recent speaker presented a paper here having to do with the citizens living within a metropolitan area who know practically nothing—many of them know practically nothing about our problems concerned with the Indiana Dunes and so on. He suggests that we make sure that we get this story to our public.

For instance, the theme for the National Wildlife Week this year is water, and we have spot announcements. Right now in Pennsylvania we are having difficulty in getting some of those across even with many years of encouragement.

I don't know whose responsibility it is going to be to help the OWAA educate the editors of all of the newspapers of the importance of publishing the prepared releases of Oklahoma and all the other states and provinces because the outdoor editor is the last man to rule on what goes into his paper, and many, many papers in this country do not have an outdoor writer, and an outdoor editor. The editors won't go along with our promotion, and we need help in trying to get a writer who knows what he is writing in every newspaper in America, in every radio station in America and in Canada and in Mexico, but if we can get somewhere a force that will promote that, then many of these controversies and many of these unknown things that all of the people should know, of course, we can reach them.

I made that as a plea more than as a comment to all of the people in the North American Wildlife Conference to keep in mind that if they have a newspaper editor in their home town who repeatedly refuses to publish these things, to use their influence to see that he does publish them.

DR. H. R. WILBER [Florida Wildlife Federation]: I have been thinking about as deep as our friend, Seth Myers, for about as long a time. I, with "Pink" Gutermuth, started this movement that you are talking about.

I would like to call this to the attention of the people gathered here, that in Cook County, there are fifty-nine sportsmen's clubs within the County. That's in a city of millions that have to drive far to get out into the country, and I would like to call the attention of this group to a thought that these men in the metropolitan areas doing this kind of a job for us are appealing where the appeal is most needed, and where it can do the most good, because after all, sportsmen's and conservation clubs are in town, and conservation is done out in the country. We still can't forget that.

VICE CHAIRMAN MULAIK: Thank you. We will have a comment from the speaker.

MR. KRAEFT: I was most interested in your remarks, sir, and I would just like to add this brief word, and not in the way of criticism. I have been the farm editor of WGN in Chicago for ten years. It is a fact that I have never in those ten years been approached by any one from any of those fifty-nine sportsmen's clubs. If they would come and say, "We have got a story to tell about this or that or the other thing," I would be most interested, but trying to cover as vast a field as agriculture in this part of the corn belt is a pretty fulltime job, and we can't go and seek out all of the information we would like to. It's just physically not possible, but if the folks will come to us and tell us they have a story they would like us to help them tell, we would be more than happy to consider it.

GENERAL SESSIONS

Tuesday Afternoon—March 8

Chairman: PATRICK HEALY, JR.
Executive Director, American Municipal Association, Washington, D. C.

Vice Chairman: GEORGE B. HAPP
Professor Emeritus, Department of Biology, Principia College, Elsah, Illinois

NATURAL RESOURCES AND COMMUNITY VALUES

REMARKS OF THE CHAIRMAN

PATRICK HEALY, JR.

City living has emerged as a typical way of life only within the last 40 years. As late as 1910 more than one-half of the nation resided in rural areas. Now it is expected that the census of 1960 will probably show that over 75 per cent of the nation now reside in urban communities.

Congress has in recent years provided an impressive array of agencies and powers to help urban communities improve the general environment in which their citizens live and work. These include such things as the establishment of mortgage insurance to encourage home building and home ownership; the subsidization of rent of families in lower income groups resulting in some 600,000 new public housing units built in former slum areas of over 1000 communities; the clearing and redevelopment of slum and blighted areas through the urban renewal programs; interest-free advances for public works planning by communities; and direct loans for public facilities in small communities who are unable to get reasonable loans in the private market, principally for construction of water and sewer facilities, matching grants for hospital construction and several others.

Now these programs relate primarily to the environment inside the city and town, but we in the cities must also be concerned with natural resources of the nation and their relation to community values, particularly for such reasons as recreational facilities, the preservation of open spaces in our rapidly urbanizing areas, the conservation of water and so forth.

I have been trying to figure out why I was asked to preside at this particular conference session, and I suppose that it had to do with the interest of the American Municipal Association of which I am the executive director in water pollution control.

Our association worked very closely with certain wildlife groups, conservation groups, as you know, in persuading the Congress to enact the Water Pollution Control Bill of 1956. We worked very closely with these groups again at this current session of Congress in persuading the Congress to pass an expanded program of water pollution control which would have made available 90 million dollars a year in Federal grants for construction of sewage disposal plants, vetoed a week or so ago by the President, but we will continue our efforts, and we hope that we will continue to have your cooperation to bring about a more realistic and a more expanded program of Federal participation in water pollution control programs.

We use the facilities of our association which, by the way, represents some 13,000 cities and towns throughout the United States, to do a certain amount of research, to gather information and present the facts to the Congress in an attempt to persuade Congress and Federal agencies to recognize some of these urban matters.

AMERICA THE UGLY

BERNARD F. HILLENBRAND

Executive Director, National Association of County Officials, Washington, D. C.

It is a sad commentary on America that the very things that have made the country great are now making it the ugliest looking nation in the world. The energy, imagination and drive of Americans that have created the greatest material benefits ever enjoyed by civilized man have also created the neon sign, the treeless suburb and the stench of the polluted stream.

The aim of these remarks today is to enlist the support of conservationists everywhere in the cause of preserving a tiny part of the innate natural beauty of America for those poor souls who are doomed to live out their lives in the urban areas of the nation. We are talking about 70% of our population today; 85% of our population in the year 2000. We hope that we can get conservationists interested in supporting a specific proposal that I will make in a few minutes.

PROBLEM

The problem is clear. Until now we have determined as a matter of national policy that nothing must stand in the way of building industrial might, a high standard of living and great material well being. We have been tremendously successful. Our philosophy has been something like this. We have to have jobs for our people and we must have industrial development even if the factories pour poison into the drinking water and pollute the air we breathe. People must have houses and the builders have raced into the suburbs and piled one sub-division upon another with absolutely no plan whatsoever to preserve any open space. Our civilization rests upon mass consumption and we must have billboards jammed on every inch of our highway urging that we eat more crunchies or buy more electric blankets. Trees do not pay taxes and they must be chopped down to make way for a pizza parlor.

The solution is also clear. We must now develop a new national policy that will both increase our material benefits and more important, create surroundings that are pleasant enough to allow us to enjoy these material things. Our premise is that a factory can be pleasant and inoffensive to humans; a highway that is beautiful can also be as useful as one that is not; and, suburbs can be constructed to preserve natural beauty and still make a profit for the builder.

LEADERSHIP

What is needed is immediate awareness that a plea to preserve natural beauty is not a move to stop "progress." We are ***not against*** progress. We are *for* conservation of the American countryside.

It is possible to have natural beauty and still accomplish our other national aims. It does take action. Immediate action. We must get key areas under public control. Open spaces must be preserved, now.

At the outset we would like to make it clear that while this is an urban problem it is not a municipal problem in the sense that it is going to be solved by cities. The key unit of government here is the county—or rather a partnership between city-county and state with the county being responsible for action.

COUNTY PROBLEM

Cities for the most part are almost completely developed and there are few open spaces to preserve. Most of the areas that we are talking about are outside the city—physically and jurisdictionally. In the typical urban area, the city is also handicapped in this problem because it does not have the broad tax base that is necessary for the initial expenditures to secure these spaces. Then too, in the typical urban area there is not a single city but rather a welter of smaller municipalities—and it is always more difficult to get things done when you have too many cooks.

Counties by contrast are in a position to act. They have a long tradition of service having been formed at the earliest dates in our history. They predate most other units of government. They have political leadership and area accountability; two very important attributes in solving any governmental problem. Most of the land we are talking about—the picturesque farm—the patch of woods—the stream and valley—the areas that must be preserved from ruin—are out in our counties. Equally important, the county is a unit of government that serves both the city people and those in the rural or semi-rural areas outside the city. With few exceptions all are represented on the county governing body. Counties have an areawide tax base to draw upon for finances and have very strong ties with the state legislatures.

BLUE PRINT FOR ACTION

If we have identified the key unit of government we also have a plan of action suggested by William H. Whyte, Jr., author and Assistant Managing Editor of *Fortune*. Some day when we do have an adequate program of preserving open spaces we are going to get behind a movement to have them renamed "Whyte Spaces" in honor of Holly Whyte. Most of you, I am sure, have read the August 17, 1959 issue of *Life Magazine* in which he sets forth his plan to preserve "the vanishing U. S. Countryside." This is a review of that plan with some suggestions that we in county government might add.

The basic tenet of the plan is to buy ''conservation easements'' to preserve certain farm and undeveloped lands from being swallowed up by the developers' bulldozers. A county can purchase the development rights—for a fair price—and insure that a farmer or land owner will not be forced by economic pressure to sell to the developer. The easement is one of the oldest legal devices we have and has been used successfully to preserve undeveloped areas around airports and scenic places along highway rights of way.

It is basically fair. It compensates an owner now for the money that he might have made by selling his property to speculators. It enables the farmer to continue farming. It preserves the beauty of the area and thus enhances the value of surrounding development. It is much less expensive than outright purchase of land and in most cases can accomplish the same purpose. It opens the way for subsequent purchase of areas for park or recreation purposes. Conservation easements do present many problems but it does appear that these can be worked out. Santa Clara County, California, is a pioneer in this area. Thanks to its Planning Director, Earl J. Belser, Santa Clara County has found the key to true urban-rural living; town and country co-existing without one destroying the other.

PURCHASE LAND

Of course, the obvious way to acquire streams, valleys, forests and other open spaces is to purchase them. In many cases this will be the most practical solution. It must be done, however, before the price becomes too high. Imagine, for example, what it would cost today to purchase Central Park if it were not publicly owned. Much desirable land will also be donated for public purposes and provide the land for future park and recreational areas.

Note the emphasis upon either purchasing land or easements immediately. This is a far better approach than spending precious time and money on area-wide studies although it is apparent that these will be needed, too. The trouble is that too often a prolonged study on open spaces results in loss of the very spaces that the study will eventually conclude should have been purchased in the first place. It is certainly better to have too much open space than too little.

Emphasis upon action to acquire open spaces is not to be interpreted as down grading the preparation of a sound area-wide land use plan. Our problem is that we have reached a crisis. We must act now and take a chance that there may be error. Obviously every community should have a well thought out area-wide plan for community development. Federal matching grants to smaller counties and cities are available for this purpose. In the case of areas that can qualify as metropolitan or regional in character, assistance is available to even the largest of communities.

Once a plan is developed it must be protected by adequate zoning regulations. It must be admitted that much of the open area that has to be preserved is located in county areas where no area plan has been developed and where no zoning protection exists. It must also be admitted that perhaps in the case of preservation of open spaces, the use of zoning is inherently unfair to private land owners who must suffer the financial loss incident to not being able to develop their land and thus the public benefits at the expense of the few.

NATIONAL COMMITTEE

We at the county level, acting through the National Association of County Officials, are well aware of our responsibilities and are solidly behind the plan to preserve the innate beauty of America. We think that one of the most important elements that is lacking, however, is national leadership and direction. Ideally we probably need another Teddy Roosevelt to give expression to the sentiments that lie deeply inside most Americans. Plainly this is a national problem if ever there was one and it will require national direction to coordinate the work of nearly every citizen who must eventually become involved.

We would, therefore, propose to you now that we get behind the idea of creating in this Session of Congress a National Committee to develop a national plan to preserve the natural beauty of America. You will recall that a few years back the President of the United States appointed a similar committee to examine our national highway needs. The Commission was headed by an outstanding American, General Lucius Clay. The Clay Committee inventoried our national road needs and came up with a plan which, with important modifications, eventually became the basis for our present gigantic highway building effort.

A committee of this type with adequate representation by conservationists, public officials, businessmen, labor leaders, newspaper representatives and other outstanding citizens could perform a tremendous national service if it accomplished nothing more than to identify the problem more clearly in the public mind.

It appears now that we have a spark plug here, a tire there, and a motor there, but we need to put it together and make a national vehicle. A committee could report in a year—to coincide with a new administration in Washington—with recommendations that could provide national direction.

AROUSED PUBLIC

We need an aroused public that understands that the natural beauty of America is as precious to natural resources as iron or oil and that like the latter, its preservation and sensible use can bring important economic advantages to all citizens.

The National Association of County Officials invites you conservationists to join us in this effort because we have conclusively proven that a partnership between the two groups can be profitable to America. You will all recall that in 1956, conservationists and local public officials joined together to support national action to clean up the nation's streams. You also know that in spite of setbacks here and there we have been able, through this partnership, to develop an important first step—the 1956 Water Pollution Control Act. At last we are beginning to get public awareness of the soundness of our recommendations and it won't be long before we get conclusive results.

It would be a particular pleasure to continue this partnership with "Pink" Gutermuth and the other outstanding conservation leaders in this most challenging new area.

Perhaps the way to conclude this is to repeat the Oath every Athenian took upon reaching manhood. It expresses in a few words the attitude the Americans must adopt if we are to continue to be great.

> "We will never bring disgrace to this our city, by any act of dishonesty or cowardice; we will fight for our ideals and sacred things of the city, both alone and with many; we will revere and obey the city's laws and do our best to incite a like respect and reverence in those around us; we will strive unceasingly to quicken the public sense of civic duty; and thus in all ways we will strive to transmit this city not only not less but greater, better and more beautiful than it was transmitted to us."

DISCUSSION

VICE CHAIRMAN GEORGE B. HAPP: This is an excellent way to open up the discussion on natural resources and community values. We hope you will have some very pertinent and very definite things to say about it.

Do you think that we are prepared for a movement on a national scale in this direction? This is, of course, a very challenging aspect to consider. But the urgency of the situation may demand it and may require it.

MR. R. E. MCDERMOTT [State University, University Park, Pa.]: What were your objections to the zoning activities, sir?

MR. HILLENBRAND: I don't know if we can use the word "objection," but if you take somebody's farm or woods and zone it against a commercial development, I think you are being unfair to him because there is no element of compensation and he might very well be able to sell it under normal conditions for industrial development or subdivision and make money on it. The basis of what we are talking about in the preservation of open spaces, should be adequate compensation. In other words, we are not going to reserve these lands for the public good and make the individual owner bear the financial loss.

That's why I believe that in many cases the use of zoning for this purpose is unfair to the people who own the land. In Santa Clara County, for example, they were able to purchase the development rights on farmland for something like $15 an acre, which means that the farmer then agrees to keep this land in farm use or some similar use and will not sell it to subdividers and so we can keep the open spaces, farmlands and other things we are trying to preserve.

There is one thing I would like to say. We have made this observation about conservationists, and again we have had quite a lot of experience working with your national people on water pollution control. We will be honest about it. We think too often you have been concerned with mating habits of salmon and wild ducks and not concerned with people. If we are going to get any real national understanding and real grass roots support for some of the things you are doing in the area of conservation, I think they have to be equated in terms of human needs, in terms of people instead of in terms of wild animals, not to say you haven't done a tremendous job. You have. Without a group of conservationists this country would really be in a pretty sad state, but when you are talking about natural areas in many of your meetings, I notice you are talking about national parks and national forests. If you look at the record, there are something like 30 or 40 million people a year who go to a national forest—about 25 per cent of the population in the country and you have the great, the overwhelming mass of Americans who never even get into a national forest or national park or even see a wild duck. The big thing they are concerned about is the little woods or park or playground or something in their immediate area, the thing they are going to see every year and their children are going to use.

The thing we are proposing here, a national commission of some kind to focus national attention on this which could provide a very worth-while vehicle to get that kind of human interest in what you are doing.

I think that very often you conservationists are talking to each other and you are not really getting out to talk to the great masses of people—the 75 per cent of the people who live in the urban areas who are not likely in their lifetime even to get to these national forests and parks and other wilderness areas and other areas you have been striving so hard and so successfully to preserve.

MR. A. H. UNDERHILL [Trenton, N.J.]: I would like to ask a question in connection with the acquisition of development rights. I can see that in the blighted areas you could acquire development rights for $15 an acre or a comparable figure, but in a state like New Jersey in the past ten years we have seen farmland which was selling for $200 to $500 an acre jump to $1000 or $1500 an acre as development sites, and it doesn't seem feasible to me that Mr. Whyte's suggestion of acquiring the development rights of that land is within the economic capabilities of most of the agencies of Government. Development is so eminent that you almost have to acquire outright this land in order to preserve it because the development rights have increased the value, and a man that has a 100-acre farm that he is just making a living on, realizes that he has got for his children an investment in the bank, so to speak, that he can turn over for several hundred thousand dollars almost any time he wants. I wonder, is it your feeling that in those areas that outright acquisition is the only answer or that development rights can still be acquired?

MR. HILLENBRAND: I am not too familiar with the situation in New Jersey. We have got an expert on that coming up next.

I know that New Jersey is the most urban state in the nation, but I come from Maryland, and the property values, I can assure you, around the Washington area are extremely high, and this is a relative thing. I am sure you couldn't buy development rights in any farmland around Montgomery County for around

$15 an acre. Maybe you would pay $1000 an acre versus paying four or five, to ten thousand dollars an acre, for outright purchase.

You have to look at this problem also from the point of view of the man who owns it. The small farmer—and we have hundreds in our county—would like to keep farming, but he is not able to keep farming because he gets tremendous offers from the developers, and even if he could resist those, you have the problem of development of surrounding areas. Subdivisions on adjoining farms, water supply and sewage disposals and schools, and a corresponding tax problem. The taxes keep going up, and ultimately you force the farmer out of business.

I think a combination of using easements for the people who want to stay on the farm would at least be a good holding action. It would at least delay the day when the pressure becomes so great that the only way you could hold it would be to purchase it. Perhaps by that time the American people realize that we have to have action, we will have a far more favorable climate locally for the outright purchase of these sites, which I assume ultimately we will have to do.

They will have to be purchased and be in public ownership. That is ultimately the only real fair way to handle it. You have to consider this again. We represent the county officials, and a public official unless he gets a lot of support from groups like your own, has to make some painful decisions. He has to decide whether he is going to spend a half million dollars for acquiring park lands or if he is going to spend that same half million dollars to build schools or to build an airport, a section of a highway or some other public need, and up until now, unfortunately, the temper of the citizenry and the general public has always been in favor of spending money for the more immediate and more apparent public needs rather than for the acquisition of land that would be used for park or recreational activities.

MR. WILLIAM L. WEBB [Syracuse, N.Y.]: I would like to ask you if you have pushed zoning over to the side as a difficult or impossible situation. Why isn't it possible, as has been done in some parts of the country, to zone to the extent of requiring developers of land to set aside a considerable area as open land to be turned over to the town, municipal or county government to be held in perpetuity? We do it with roads in the development site. The developer puts in the road to certain standards—grades, water, drainage and so forth. Why can't we do this with open lands?

MR. HILLENRBAND: I think we can. I don't want anything I have said to indicate to you that we are in any sense downgrading the use of zoning. Every community should have an area plan protected by zoning, but it's significant that in Santa Clara County they initially established what they called agricultural zoning. For example, they would zone the golf course as agricultural and some of these other places, but they found again that the economic pressure from the high amounts of money that were offered from developers and industrial site selectors, and the ease with which the zoning could be broken, made it a fairly ineffective tool.

The real answer, of course, is that we need a whole bagful of tools—zoning, purchase, easements. We need a whole variety. Every community has a different approach.

Now many counties have tried what you have suggested. Before they would approve a plot to be developed into subdivisions they would insist that a certain percentage of the land be set aside for open space, and actually of course, that works to the enormous benefit also to the developer because, if there are pleasant surroundings, little lakes and streams and forests and little open spaces, farm land, that is being actively farmed and so on, it certainly enhances the value of the surrounding development. The big thing is to impress upon everybody that we have to do something. Regardless of what we do, we have to do something to preserve these spaces. Once they get started building factories and hodgepodge development, in the suburb, it's too late.

MR. SETH MYERS [Sharon, Pa.]: It seems to me there is one feature that you overlooked or didn't mention. That is an educational program at the local level.

In Pennsylvania we were all set to develop a recreational area on Sandy Creek, and a little handful of men, including one of the three county commissioners on the side went up along each side of this stream and bought up a lot of land and now have blocked the thing because of the exorbitant demands. I think time after time that develops in local areas that two or three greedy people will block the development of a well-intended local project, and so somewhere—I don't know how or where in the world you are going to educate a person not to be greedy, but that's exactly what is happening in many of these projects in the county levels, state and incidentally national levels.

MR. HILLENBRAND: The only thing you can say about this. I am sure this county official is a very unusual one. Most of them are not greedy.

MR. MYERS: I might add to that everybody said, "Yes. The next election we will take care of those guys," but they don't, or if they do, some other greedy guy gets in.

MR. HILLENBRAND: Well, I think that the answer to that is that we have the supreme tool. We have the right of eminent domain, and that can be exercised only when the public is sufficiently aroused and action bent. If we can get a great grass roots program going of people at last getting aware of this, the citizenry will be much more favorably disposed to using eminent domain and purchasing these lands.

They will realize they have to make the sacrifice now to acquire the lands for the future, and unless we miss our guess, judging from the number of articles we are beginning to see in the national magazines, judging from speeches we hear before these Kiwanis groups and other groups and so on, there is a tremendous latent feeling of frustration in these urban areas that people go and move out to the suburbs to see trees and bees and birds and things, and all they see is the tail fin on the car in front of them going back and forth at night. They go out and select a site that is out in the woods, and there are farms around, and in a couple of years it's all gone. It's all cemented over and all developed into one development after another, and now is the time to get some action to capitalize on that feeling and start on a real grass roots conservation program so that every city, every county and township and state and everybody is conscious of this, and that everybody is in the business of acquiring these lands and trying to preserve the areas we are talking about.

VICE CHAIRMAN HAPP: I am sure you are well aware this is a creeping situation, that any of you who have traveled between Washington and Boston by car or by train or by plane realizes that there is a constant zone of suburban areas between Washington, Philadelphia, Trenton, New York and on to Boston.

You see the same thing happening up the Hudson Valley, and it won't be long before it will sweep on toward Buffalo, to Cleveland, to Detroit and Chicago.

Now we just look at that, and we don't think: Oh, that is something far distant. It isn't far distant. You can see it around any large urban area.

We may think again if we get far enough away we don't have to look at it, but as our speaker has said, a large majority of the people don't get far enough away, and they do exist in close contact with this sort of situation. It's one that certainly challenges our foresight and most of all, our actions.

HOW CONSERVATION HELPS BUSINESS AND INDUSTRY

ROBERT B. MEYNER
Governor, State of New Jersey, Trenton, New Jersey

America is a rich land—rich in human and natural resources. In the eyes of the historian we are a new land. It is only under the impact of the space age that time has telescoped and we in the United States suddenly find ourselves a mature Nation. We are fortunate, in the sense that we have reached maturity while our resources are not yet impoverished. When Egypt, Greece and Rome came of age, their natural resources were nearly exhausted. We are still strong—but even more important, we are developing a conservation conscience. Our natural resources are the basis of our strength. Business and industry have used them to develop our wealth and expand our civilization to its present pinnacle. Certainly guarding and protecting these resources—we call it "wise use"—are essential to the preservation of business and industry—essential, in fact, to survival.

We need touch only briefly today on the non-renewable resources. They must be used with a minimum of waste. Even more important, we must foster vigorous research to continue to find substitutes for what were once thought to be irreplaceable materials. Today we appear to be on the point of discovering the very nature of matter. Tomorrow we may be able to create so-called strategic materials by the rearrangement of atoms, protons, or as yet undiscovered particles. Man's mind is his greatest asset. We must develop scientists and philosophers and give them freedom and encouragement in their search for knowledge.

If you are looking for inspiration in this area, I recommend that you read *Science and Resources,* a book prepared by Resources for the Future, Inc., and published by Johns Hopkins Press. Here is an account that permits us to peer into the future. We learn how to project the abundance that could be ours from selective breeding of seeds and livestock, from soil enrichment, from weather and climate control, from the mining of oceans and the exploration of space, and from opening up continental interiors and polar regions and blasting deep into the earth's crust for minerals.

These are developments which are not only possible in our lifetime but probable, if only we concentrate our efforts. Our starting point must be the knowledge that our pivotal resource is energy—abundant, inexpensive energy. It is from this source that we can expect to multiply our other resources. Our scientists already know how to produce energy from fission. Now we must use this knowledge by applying the fusion process to the limitless amounts of strategic materials available under land and water.

There are those who fear the consequences of harnessing the full power of science and technology to our resource efforts. They fear the consequences of a breakthrough, just as, in the past, some feared the coming of power machinery and the tractor. Admittedly, great changes in developing our resources can give rise, in some quarters, to a legitimate feeling of insecurity.

I believe these fears can be put to rest. I believe that in the process of harnessing science and technology we can adopt policies and procedures consistent with the precepts of constitutional law and the accepted codes of our democracy. But we cannot afford to delay any longer. If we lived in a world apart from other nations and the ambitions of other nations, conceivably we could let time move us ahead at its own pace. But we do not live alone. Our destiny as a Nation and one of the family of nations hangs on how quickly and wisely we act.

Dallas, the home of the Cotton Bowl, may be a good place to suggest that what we need to do immediately in this Nation is to call for some major huddles. I have a feeling that in too many respects our Nation is like a disorganized team executing some fancy backfield maneuvers but not doing any scoring. If we are to hit on the right play we need a meeting of the minds. In the area of science and technology they should be minds of the highest integrity, intelligence and justice.

This conference should also establish priorities for research and development. We should, as we did in the Manhattan Project, develop specifications for the personnel that can be rallied to engage in this effort. We should arrange to provide investment funds through public and private sources. And, in adapting new resource developments to our existing economy, we should take steps to cushion the damage to those who will be adversely affected by such developments.

But this conference today is primarily concerned with the so-called renewable natural resources, and my role is to try to relate them to conservation, business and industry.

Ours is a complex and interrelated economy. All business and industry, all life for that matter, depend on renewable resources for their survival. History records how the rise and fall of great empires hinged on the wisdom with which these resources were managed. Abraham Lincoln said, "We cannot escape history." Perhaps I, as a Democratic Governor, speaking in the great Democratic state of Texas, should apologize for quoting so eminent a Republican. But I prefer to think Texans do not want to escape history, any more than you want to forget the Battle of San Jacinto, or erase the memory Sam Houston.

Some of us in America may be trying to escape history, but we are already showing signs that we cannot afford to ignore the experience of earlier world leaders. Certainly we cannot cast aside what we have learned in the field of conservation. Let us consider then some of our conservation programs and conservation agencies in terms of their specific resources—such as soil, water, forests, fish and wildlife, and the air above and around us. Recognizing, of course, that all are interrelated, let us consider how each of these affects business and industry:

SOIL—The creation of usable soil by chemical and physical factors is a continuing process. Unfortunately it is too slow for practical application, if we do not preserve the fertility of what we have. Theodore Roosevelt (if I may quote another Republican) once said: "When the soil is gone, man must go; and the process does not take long." That statement still holds. Until we can harness more adequately the productivity of the sea, the production of our food and fiber will depend on the conservation of our top soil. No nation can long remain strong if it does not preserve and utilize the fertility of its soils. Here we have a part of the foundation on which business and industry must rest.

The "wise use" of soil is a responsibility of society. It so affects the wellbeing of the nation that it becomes a national concern. The federal government cannot shirk this responsibility. The Soil Conservation Service was established in the Department of Agriculture during Franklin Roosevelt's administration. Its expansion since that time has been an example of the development in the United States of a social conscience in the management of our renewable natural resources.

We have made great strides in educating the individual with respect to the importance of soil conservation, and various federal subsidies have helped. But only a political body, in this case the national government, can give continuity to such a program. The dust bowl in Oklahoma gave us an example of what can happen under a policy of laissez-faire. While personal suffering was more diluted, it was as much of a disaster to the people of New Jersey or Oregon as it was to the farmers of Oklahoma. Soil conservation in our great agricultural areas is a national concern. It vitally affects every business and industry—every American!

The second resource I mentioned is WATER. It is appropriate that water conservation is the theme of this year's Wildlife Week. Our world has no shortage of water, but it is not always distributed to suit man's requirements. Civilizations develop where the annual water supply is abundant, or where man's ingenuity can provide it.

New Jersey is fortunate; its annual supply far exceeds current needs and those of the foreseeable future. Yet water problems have concerned New Jersey since colonial times. The answer to this paradox is simple: We must have water at the right place and at the right time. Once again the "wise use" definition of conservation applies. We are proud of our water management. With the English riparian doctrine as a cornerstone, New Jersey has developed legislation which permits orderly utilization of both ground and surface water. To a considerable degree, flood waters have been controlled and, as demand required, storage facilities have been provided to meet year-round needs.

Business and industry must have water. Like every other consumer, they must use it so that others may re-use it enroute to the sea. Pollution is waste. It would be ridiculous for me to claim that in New Jersey five and a half million people can live on an area of less than eight thousand square miles without serious pollution problems. New Jersey's record, however, is good. Strong anti-pollution laws and intelligent enforcement can maintain clean water for re-use by industry and continuous use for outdoor recreation.

Even as the conservation of soil is a national concern, so is the preservation of clean, re-usable water. The record of the U. S. Public Health Service is good. The advice of the National Water Pollution Abatement Commission has been sound. The authority of both can be strengthened. In that connection it seems inconceivable to me that the national administration has seen fit to veto the amended Water Pollution bill, which would have made available $90,000,000 annually for municipal treatment plants. Population and industrial growth are often so rapid that local financing cannot hope to cope with the pollution load. Every American living and yet unborn has a stake in clean water everywhere on the continent.

The next resource is FORESTS. Our wood and pulp users are already demonstrating that conservation pays. Each year more private holdings are going on a sustained year basis. For short rotation crops, such as pulp and boxwood, the private economic benefits of such a policy are quite obvious. But except for very large corporations, long range lumber conservation seems much less attractive. Like Omar Khayyam we are tempted to say, "Ah take the Cash and let the Credit go, Nor heed the rumble of a distant Drum!"

But as Europe discovered before us, national interest demands management by a political entity that can insure some measure of continuity to plan for the future. In the field of forestry America has demonstrated its best conservation progress, and the U. S. Forest Service has furnished real leadership. Together with state and private foresters, it has fostered programs which are making Americans forestry-conscious. Of our 461 million acres of forest land, some 280 million are privately owned. In spite of federal and state programs, much of this land is not under intelligent forest management. We continue to cut and use more than the annual increment of our forests.

Forest lands in public ownership assume greater importance for recreation as population and leisure time increase. The need for healthful outdoor enjoyment must be met. But as government leaders we will have to curb the parochial enthusiasm of professional foresters, wildlife managers and water engineers alike, so that multiple use management best serves the broad public interest. Again, business and industry will reap both direct and indirect benefits from intelligent conservation.

Let's consider now FISH AND WILDLIFE. Our marine fisheries and certain fresh water varieties support substantial commercial industries. Fur-bearers are in the same category. These industries, under the guidance of the states and the U. S. Fish and Wildlife Service, are passing from a period of unrestrained exploitation to an era of responsible cooperation in resource management. Of even greater economic significance are the businesses and industries associated with recreational hunting and fishing. According to a 1955 survey, some $3 billion is spent annually in the United States by devotees of these sports.

Intangible benefits are even more significant. Who can measure the impact of a windy dawn over a wild marsh, or a peaceful May morning along a rushing trout stream lined with shad bush?

I am not an inveterate fisherman. Some might even say my angling expeditions have political motives. Be that as it may, I have joined New Jersey's thousands of trout anglers on opening day for six of the past seven years. Evidently, my position as Governor did not impress the trout. While those around me were catching the legal limit, I creeled three trout in six years! Nevertheless I felt my time was not wasted. I recognized what those days afield mean to fishermen. Here are tens of thousands of happy, smiling men and women enjoying their favorite relaxation. In our troubled world, such relaxation is more than a luxury. It is essential to the maintenance of sanity and perspective.

Today we find business and industry seeking outdoor recreation for their workers. An increasingly important factor in locating plants is the kind of hunting, fishing and outdoor recreation that will be available to employees in leisure hours. In our industrialized and highly urbanized State we found we must integrate these concepts into plans for orderly development. Wise land use requires wise planning. Planning is a social responsibility for all levels of government. Home rule is still vital to America, but resource planning transcends local considerations when these conflict with the common good. At the national level we have not been furnishing the leadership and integrated planning we need.

Finally, and I should say appropriately, we approach the resource of AIR and the ATMOSPHERE around us. With smog blights causing death and physical discomfort in some of our metropolitan areas, the problem of air pollution has become much more serious. Cities and states have launched intensive programs to cleanse the atmosphere.

The development of military and civilian jet planes which break the sound barrier threatens peaceful living in our cities and suburbs.

Strontium 90 has been added to our aerial diet. The amount of fallout and concentration of atomic substances in the atmosphere not only endanger the lives of our children but threaten the future of mankind itself.

We must evolve a sound national aviation policy predicated on the safety and rational needs of peaceful living. The aviation specialists must learn to treat citizens as more than mere inhabitants of houses that lie in the path of proposed landings and take-offs.

We must search for and adopt a world nuclear policy that will insure two billion, 800 million world citizens an atmosphere which will allow normal living and the perpetuation of the species.

Some of us are inclined to boast of our alleged superiority in production, in developing new means of communication, in building better mousetraps, in satisfying our material wants. Some of us may think these achievements, real or fancied, represent a victory over other nations and other people. But it will be an empty victory if it should cost us, one by one, the loss of those tokens of civilization that, taken together, add up to the satisfactions of life. We must learn to strike a sensible balance between meeting the needs of our diverse economic interests and the needs of our people as human beings—individuals with a right to air, space, beauty and quiet.

I have touched only briefly on the moral and esthetic issues. Man's aspirations for a fuller life—a better world—are welded to the bounty of this earth. Appreciation of rich soil, pure water, stately forests, clean air, and an abundance of creatures other than man which share our world, is a part of this aspiration. These resources must be used if we are to survive. We, the richest Nation on earth, cannot afford to stand by while they are misused.

In a dynamic day, when our population and national wealth are growing at an unprecedented rate, drift is inexcusable. It represents an abdication of responsibility.

How pleasant it feels to be fat and comfortable, and to ignore the problems of our day! How significant it is that we are concerned about the height of the tailfins on our cars, but not about the rate at which we destroy our heritage! How expressive it is that we are status seekers in dress, housing and transportation, and turn our backs on our natural resources!

More than 200 years ago Oliver Goldsmith, witnessing the elimination of the common land under the Enclosure Acts, wrote in *The Deserted Village:*

"Ill fares the land, to hastening ills a prey,
Where wealth accumulates, and men decay."

And William Wordsworth, writing at about the same time, said:

"The world is too much with us; late and soon,
Getting and spending, we lay waste our powers;
Little we see in Nature that is ours."

How well these poets, nearly 200 years dead, wrote words appropriate to our day! Those words represent a challenge, to demonstrate that a free people can make wise decisions to conserve our values by conserving our resources. We must demonstrate that a free people can share responsibilities and take action whether we do so as individuals, or within our economic enterprises and universities, or through our elected representatives.

Our own people are watching to see how well we do. People throughout the world are also watching. I am confident that, given the facts and the leadership, we will do well.

DISCUSSION

CHAIRMAN HEALY: Governor Meyner, that was a most interesting and constructive address and it was a good indication of your own strong leadership qualities, and we thank you.

MR. SETH MYERS [Sharon, Pa.]: I can't let this go by. About 308 years ago, Izaak Walton compiled a book, *The Compleat Angler.* All through that book are mentions of political interference which would probably prevent the cleaning up of the streams, and for 300 years we have had that political interference. All of these great conservation organizations have fought hard through the years.

I am representing the Outdoor Writers of America. There are other officers in the audience of the same organization, and I think of every conservation organization in America. I would hate to say how many telegrams I submitted to Washington on behalf of the Blatnik Bill. I think probably every man here has done his part, both Republicans and Democrats, to prevent the veto of the Blatnik Bill.

I just want to comment that as long as we as conservationists are fighting our hearts out, and we have great metropolitan newspapers who either justified or unjustified or deliberately or unintentionally publicize wide headlines on an editorial to metropolitan papers in Philadelphia, now whether deliberately or otherwise, they publicized the idea that the Blatnik Bill called for 900 million dollars. They naturally called it a pork barrel and got people to write in against it.

Now, it was only 90 million dollars, which is on a small amount in this great battle for the survival of good health in America. That was a political gimmick as sure anything in the world, not because it was mentioned as 300 million dollars once, but in one editorial and the editorial is present here. A gentleman from New Jersey, incidentally, has a copy of it here in the building. Three places in the same editorial it said 300 million dollars.

That, Governor, is why we are having such difficulty. Congress apparently lacks the fortitude to override a veto for the good of all the people. I don't know whether anybody else in the room is mad or not, but I am boiling inside ever since the veto. I just wanted to leave those comments with the gentleman here.

GOVERNOR MEYNER: Of course, I believe politics is the art of the possible, and I have a great respect for people who have ideals and engage in this kind of enterprise. I think some of us who are very much interested in these bills have a job to do in educating newspapers and educating editorial writers, in educating people who hold office as to the virtues of these programs.

I might say as a chief executive and a leader of my party I have found that aroused sportsmen are some of the most effective groups, and perhaps conservationists and sportsmen who are interested in this bill can make their views known to the press, to the various agencies, public communications and to the Government with the hope that in the not too distant future such legislation would be approved.

VICE CHAIRMAN HAPP: These are very stirring questions. I hope we appreciate them. They are very essential. We don't have a Bunker Hill to arouse our enthusiasm in quite the same way, but the questions are just as pertinent as they were in those days.

MR. W. C. ROYALL [Nacogdoches, Texas]: Mr. Hillenbrand said that we conservationists have got to stop talking to each other. I think here is a good opportunity in Governor Meyner's speech to stop talking to each other. If the Governor will give this same speech to conventions of engineers and attorneys and other people in the country, we might get somewhere farther. Thank you.

GOVERNOR MEYNER: I will certainly try to comply with that suggestion that I give the speech on other occasions to people who are classed as perhaps not active conservationists. I think Mr. Hillenbrand and you have sort of epitomized a problem that we have in civilization generally, that we have in a democracy throughout the United States. All of us tend to live in a vacuum. The attorneys meet and discuss their common problems. The bankers do the same. The mortgage men do the same. The various professional and business groups do the same.

It's my firm belief that we in the United States have to devise in our ingenious fashion, and we have a greater capacity to develop organizations than any nation in the world, a method by which we can break down some of these barriers, and we see not only the specifics of the profession we are engaged in, but that we enlarge our interest in making an appeal to a larger group of people.

I think it can be done. As a chief executive of the State of New Jersey, through press conferences, through weekly reports to the people, through frequent appearances amongst the public we have brought many of the problems of state and local government to people who might not otherwise get such a view.

I certainly think public relations devices on the part of conservation groups are available if we but have the ingenuity to utilize them. Radio and television and newspapers are interested in discussions. They are interested in having a certain amount of space or time occupied by things which have a public interest, and those who are interested in these programs can certainly utilize those sources.

By the same token, legislation has to be enacted at various stages, and what is more important, administrative action by officials in government has to be supported, and these organizations cannot only study the problems but can implement their beliefs by a practical program, and it can be done. It has been done before because over the years we have attacked problems of disease, providing educational institutions for making advances in many areas as largely on the notion that a group of people can get together, can dedicate themselves to a proposition, can raise money to support it, and can get action done, and I feel sure that this is just one phase of activity that conservationists can utilize to a fuller extent. I am sure there is a great deal of sympathy. I don't think it's the number of people that are interested. I am never terribly interested when somebody comes in and pounds his chest and says, "I represent 300,000 people." I am more interested in the idea he has, the way he phrases it, the way he sells it, the way he can interest other people in the idea.

Very frequently some of these people who say they head up organizations, they might pay dues, and they might possibly have signed a petition at one time or another. It's the strength of the ideal that is most important, and if you have got a good idea and you can set it forth and you can back it up by argument, you can reach a tremendous number of people. That's the way I feel about conservation.

MR. RICHARD STROUD [Sport Fishing Institute, Washington, D.C.]: Governor, I think that was a very inspiring speech, and one that we should widely disseminate. In reference to this pollution problem, and since your talk was in relation to business and industry, I think all of us are aware that from the inception of this effort to extend the basic pollution control act down through the current efforts to amend it, and strengthen it, that the record is quite clear a major share of opposition arose to the extension of the original act and to this later effort to amend it has come from two principal areas of industry—the pulp paper industry and the chemical industry. Now I believe that you may have some segments of the chemical industry in your state. I wonder, in this connection and in connection with your remarks relative to the idea of social conscience in industry, what your appraisal would be of the depth of this social conscientiousness in the chemical industry in your state in relationship to the situation and what suggestion you might have, if any, as to how we might go about strengthening that social conscience so that in the next effort we might get better results.

GOVERNOR MEYNER: We do have a substantial pharmaceutical industry and chemical industry in New Jersey. We also, through the Interstate Sanitation Commission and through our Department of Health, have been putting forth a great deal of effort to clean up our streams and eliminate pollution so that those streams can be more fully utilized for recreation, can be more fully utilized for parks, playgrounds, and so that we can get some clean streams.

It seems to me that one of the methods is to work with the manufacturing interests themselves. Practically every corporation today is developing a public conscience. The people who own the shares in the corporation are more widely disbursed. There are very few corporations left where one, two or a half a dozen people operate them or are the dominant factor. There is a management group that has grown up who are operating these corporations, and they realize that to satisfy the stockholders and to exist in a community they have got to promote the public good will. Through the trade associations, through the local Chamber of Commerce, the State Chamber of Commerce, the state association of manufacturers, you can get good reaction, and if you don't get reaction, then you resort to publicity.

You announce you are going to do something about certain pollution. You go before a Grand Jury. You get an indictment, and you proceed. But my feeling has been that manufacturers are most anxious to avoid bad publicity because they have developed this public conscience.

We have found that they are ready to support trunk sewer systems to dispose of waste. We have found that they have been willing to enter into agreements to treat some of their waste before it goes into our regular sewage systems. We have gotten a good deal of cooperation.

I don't mean to say that every stream in New Jersey is completely clean, but I think by a sound policy of persistent movement by the health department working with the corporations that we have done a good job. For instance, we adopted about five years ago an air pollution law. We have an Air Pollution Commission and we have gotten on as members of that Air Pollution Commission some of the leading engineers in the industries, and you might say, "Oh, well, they are going to run it to suit themselves."

I can tell you that they have been more stringent in the pressures that they have brought upon industry than people who wouldn't know anything about it. They can't be talked out of it because they, too, are part of this management, and they live in communities, and they want clean air, and they want clean streams.

I think by working closely, being adamant when you meet a situation where no one is going to give you a response, but working with people when they have this public conscience, you can get a good deal accomplished.

MR. STROUD: Thank you.

UPSTREAM FLOOD PREVENTION

L. L. MALES
President, Security State Bank, Cheyenne, Oklahoma

Although Roger Mills County's annual rainfall is 24 inches, the rainfall pattern is one of floods or drouths, feasts or famine. In fact the drouth was so bad in the Dirty 30's the County was classified in the dust bowl, yet during this same period suffered the most devastating flood in history—a flood which caused the loss of 17 lives and enormous property and soil damage. The destruction was such that the economy of our county was prostrate. Farms were being sold for taxes. We were all but broke and knew it. We also knew we couldn't continue living under these conditions. There were only two choices, we could give up and walk out or we could stay and get busy curing our ills. Some stayed.

In 1938 the Upper Washita Soil Conservation District was organized and with it came the Soil Conservation Service technicians and the philosophy of using the land within its capabilities and treating it according to its needs. These recommended conservation practices did not cause it to rain more but they certainly showed us the limited rainfall we got could be made to go much farther toward producing crops and pastures. This helped, but even then, with the high intensity rains, we still had the old problem of devastating floods, with the destruction of homes, crops, livestock, roads and bridges in the valleys of the streams where the best land lies.

To remedy this, Congress was persuaded in 1944 to authorize the flood prevention program on the Washita River, along with 10 other watersheds. By 1948 a few small structures were scattered over the County, and they proved the structures would work but not that the program would work on a stream. We needed a tributary on which County, and they proved the structures would work but not that the Washita River was sub-divided into 64 major tributaries or sub-watersheds, twelve of which are wholly or in part in Roger Mills County.

With this sub-watershed concept in mind, a watershed plan was developed on Sandstone Creek in November, 1949. Construction got underway in the spring of 1950 and by November, 1952 the structural measures were complete. The results of the treatment of this watershed were so impressive the Upper Washita Soil Conservation District was soon flooded with requests for the program on the other creeks in the county. Today the entire Washita drainage in Roger Mills County, amounting to 504,309 acres, is under flood prevention plans.

With the completion of these plans, 290,501 acres of land will be behind 105 detention structures. These structures will store 4,969 surface acres of water. They will have a total flood storage of 180,718 acre feet and protect a flood plain area of 22,356 acres, not including the protection to the flood plain of the mainstem of the Washita.

One might wonder why this program has progressed so well in this county. The answer is simple. The people have seen the program in action and they know some of the benefits.

We have seen reclaimed to use by the owners, good bottom land that had been lost to use because of floods. As high as one third of the bottom land on some creeks. We have seen the bountiful crops harvested from these bottom lands in flood years when on untreated creeks all was lost. The reduction of flood damage to improvements, livestock, roads and bridges has been amazing. We have seen the water table rise so that even in dry years the streams flow the year round, and our farmers pick up water from these stream for irrigation to grow feed to stabilize our livestock economy. We have seen new farm and ranch homes built out on these watersheds and some young people decide to stay on the land. During the years 1952 to 1956, inclusive, we suffered a period of lower rainfall than the worst of the 30's, yet today our whole economy is flourishing. Farm-operator ownership is at an all-time high, meaning an all-time low in tenancy. Our bank deposits which were below $100,000 in the Dirty 30's are now over 3 million. Not all of this is because of soil and water conservation and the watershed program, but much of it certainly is.

Another benefit about which we are rapidly learning is the use of the reservoir pools for recreation. People from many communities for miles around come to these reservoirs to camp, fish, boat and water ski. Uses about which we had never dreamed because we had never known them. At the rate recreation is increasing, the greatest benefits may ultimately prove to be in this use. Especially in this dry area.

We are convinced the future will hold many benefits about which we are not aware today. In the years to come we may well see such great advancement in our knowledge of the use of our soil, water and sunshine that what we have done today may prove to be only scratching the surface. As of today, we visualize our rolling hills in permanent cover, dotted by these blue reservoirs, with the valleys protected from damaging floods. There the rich soil is watered by streams of clear water and by the combined use of this fertile soil, good quality water and beautiful sunshine we will produce an abundance for ourselves, our children and all who come after us. We think we have added a touch of permanency.

HOW FOREST LAND OWNERSHIP IN THE SOUTH AFFECTS THE COMMUNITY

FRANK HEYWARD

Crown Zellerbach Corporation, Bogalusa, Louisiana

To render and maintain the South's forest land in a condition compatible with maximum public good is a matter which will require intensive future study. Our present knowledge of the subject, although fragmentary, is complete enough to reveal a problem of countless complex relations and interrelations. No mistake could be greater than to over-simplify the matter. Of utmost importance to the accrual of public benefits from forest land is the ownership pattern.

To begin with, what do we expect from our forest land? First, this land must serve as a natural resources factory whose products are wood, wildlife, and ground water. It must also furnish a large measure of recreation for our expanding population. Then, too, it must serve as a source of economic benefit to owner, a source of employment for labor, and as a source of tax revenue for government. Our forest land must serve as a spillway for urban expansion by providing needed areas for real estate and industrial developments, additional cemeteries, rights of way for utilities and super-highways, airfields, and other needs of expanding city life. Lastly, forest lands must provide any necessary increases in agricultural acreage, including pasture for livestock.

We hear a great deal about the need for full production of our land, especially forest land. However, even if all forest land were fully productive, there would still be many problems before us. At first thought it might appear that, if land were producing all it can, the matter of ownership would be academic.

But productive of what? The products of forest land and its uses by the public are many. For instance, land may be producing a maximum of livestock forage but a minimum of wood fiber. Or land may be highly productive of wood fiber yet completely non-productive of wild game. A specific example is an area of planted pine trees. These artificially established timber stands represent the ultimate in wood production because they provide maximum use of growing space. Yet, the same man-made forests are usually biological deserts as far as wildlife is concerned. Within three or four years after their establishment, they have completely shaded out most plants having food value for wildlife. These plants begin to make a slow comeback only after the first thinnings are made in the overstory.

Numerous examples exist of the clear cutting of heavy stands of hardwoods. Within a few years, brush fields frequently result. The land then represents a low point in timber production but a possible high point with respect to its deer population.

Still another example is a heavily grazed woodland pasture. Here cattle production is high, timber production may be moderate, but reception of rain water by the soil extremely low owing to the compacting of the soil by the cattle.

On the other hand, the conditions of full timber production and maximum water conservation are positively correlated. As the forest approaches full stocking, the infiltration of rain water to the soil and the effect of the forest in the amelioration of stream flow approach the optimum.

From these considerations, therefore, it is clear that the use of maximum production as a term is meaningless as a measure of public benefit from forest land unless the type of production is specifically defined.

Even the designation maximum production of game or of timber is not sufficiently specific. We know that conditions favorable to one type of wild game are not necessarily favorable to another. Although there may be some overlapping of food habits between squirrels and quail, for example, conditions favorable to the maximum production of one are unrelated to those of the other.

Neither is the expression full timber production free from ambiguity. Does the owner desire full production from the standpoint of financial returns or fiber yield? Full fiber production is an objective which is ideal for a tree farm owned by a wood using industry. But, in general, a fully stocked stand of timber grows merchantable trees too slowly for the small tree farmer. His objective is the most money in the shortest time. To this end he is generally satisfied with considerably less than fully productive land from the standpoint of wood fiber, because less than full stocking yields salable trees sooner.

Still another thought should be mentioned. Growth of a forest judged to be fully productive today may be unsatisfactory in the future. It appears certain that geneticists will develop faster growing strains of trees. In this event full stocking and adequate growth as determined by present day standards may be deemed inadequate by the year 2000.

The matter becomes even more involved when one faction of the public desires full production of a forest product or use and a second faction favors another on the same area. Examples of such conflicting desires are commonplace today. One is current attempts to set aside certain areas on our national forests for recreational uses with the exclusion of further production of commercial timber. The current huge tree planting program with its temporary detrimental effect on wildlife habitat is another. Most perplexing of all is the indifference of the many small woodland owners to maximum production of anything. They are content to allow their woodland to develop along the lines of least resistance. Poor or no planning may result in the replacement of commercially valuable timber by hardwoods undesirable as to both quality and species, and of little value as a source of game food.

From these considerations it is evident that the effects of land ownership on the community are of a highly complex nature. During the past 25 years, however, numerous examples of land under several types of stabilized ownership have been available for observation. To my knowledge few, if any, formal studies of this subject have been made. My comments, therefore, must be limited largely to personal opinion unsupported by statistics.

In the ensuing comments the South's forest land will be considered under three ownership classes. These are: small private, large private, and public. The small private category, each tract less than 500 acres in size, comprises 53 per cent of the total forest land; large private, each tract larger than 500 acres, 39 per cent; and land in public ownership, mostly national forests, 8 per cent.

Let us proceed to a consideration of benefits or lack of benefits which accrue to a community from each of these three types of forest ownership. To be compared are: timber production, water conservation, recreation including hunting and fishing, and the effect on the local economy. For purposes of this paper full timber production of forest land is assumed to mean a stand of trees sufficiently well stocked so as to shade the soil from direct sunlight and rain.

PUBLIC OWNERSHIP

As a class state forests are too few in number and too limited in area to be considered on the same basis as the lands in private ownership. The 11½ million acres in national forests, however, are a significant percentage of the region's forest land. Then their general distribution throughout the South—at least one forest in each state—makes them an integral part in any overall discussion of southern forests as a whole.

As regards wood production the standard of these lands is very high when compared with the average for the South. Full production, however, will not be reached until management has continued for many more years. This is due to the considerable time required to attain this condition on any forest land and in no way reflects on past forest management.

Conditions highly favorable to optimum stream control and the receptiveness of the soil to rain water are found on national forests. The rendering of a measure of stream flow control was one of the purposes of establishing the old forest reserves according to the Administration Act of 1897. There can be no argument that to this end they have served their purpose well.

On most national forests large areas have been set aside for game management purposes. Included are refuges permanently closed to hunting and others where controlled public hunting is permitted. Deer, abundant in certain management areas, are generally on the increase. Locally, the wild turkey population is making a comeback. The squirrel has responded well to scientific game management, and on some national forests, this popular animal is eagerly hunted by sportsmen. Productive upland bird hunting is restricted to land under intensive game management practices. Fish management areas also have been developed in keeping with public interest within the limits of available funds.

Most national forests have well cared for public recreational areas such as picnic sites and bathing beaches. Boat launching facilities have been developed at many locations. Beyond doubt the standard of recreational development on national forests exceeds that for lands in private ownership.

As regards their contribution to the local economy national forests play a significant role depending, as with all forest land, upon the quantity of merchantable timber available for purchase. Although these public lands pay no taxes, 25 per cent of the returns from timber sales are allocated to the counties included in the national forest in which the timber is cut. When cut-over lands are acquired, the local government must do without any tax revenue or substitute thereof for sufficient time, usually 18 to 20 years, to grow a new timber crop. After this waiting period, however, the county's share from timber sale proceeds may exceed the ad valorem land tax several fold and even be considerably in excess of the combined ad valorem land tax and timber severance tax where such a tax exists. Even though the federal government does not pay a state severance tax, provisions are made in national forest timber sales whereby the purchaser of the timber pays the tax.

On the other hand the operation of forest land under federal ownership does preclude the collection of certain other local taxes, among which are the state sales tax and state gasoline taxes.

The inflexibility of title once land is made a part of a national forest has advantages and disadvantages. From the standpoint of wood production, water conservation, and recreation, stability of ownership is certainly for the public good. On the other hand, if acreage in public ownership is needed for urban expansion, a problem may be posed. The Forest Service has recognized this situation and now has authority under recently enacted legislation to sell for building lots national forest land within the corporate limits of a community.

SMALL PRIVATE OWNERSHIP

From the standpoint of forest production, the average for the 101 million acres in ownerships of 500 acres or less is far below that of national forests or land in large private ownerships. This condition, recognized for many years by foresters, was most recently evaluated by the Forest Service in "Timber Resources for America's Future." Only a small percentage of small owners are making a conscious effort to increase the productivity of their woodland for any purpose. On the other hand, successful fire prevention throughout the South has greatly increased the forest productivity of these lands. As explained previously, this has resulted in improved conditions conducive to conservation of natural waters.

A comparison of the economic benefits to a community from lands in large and small ownerships is difficult because the matter of agriculture enters the picture. Frequently a small wooded tract is part of a farm. In many states homestead exemption relieves the owner from payment of land taxes. Of course, large forest holdings are never tax exempt. The problem is complicated, therefore, by trying to compare the tax revenue from a combined farm-forestry economy with that for a true forest economy.

An economic problem of considerable magnitude is that a large percentage of the increased forest production, previously mentioned on small ownerships, consists of unwanted hardwoods. These are trees of low quality and of inferior species. To a considerable degree, therefore, the forest site is growing wood fiber neither usable now nor likely to be in the foreseeable future.

A real value to the community of lands in small ownership is that many of these properties are bought and sold each year. This is a healthy situation. It would be unfortunate from many points of view if land titles ever should be so frozen that no more land could be bought. Obviously there is little chance that land in national forests will be offered to the public for purchase and scarcely any greater chance as regards industrial forest holdings.

Quite frequently paper companies are criticized for acquiring numbers of small holdings thereby freezing title. This matter will be discussed later.

Small ownerships already furnish a great deal of hunting and fishing for the public. Practically all upland bird hunting by the public takes place on this class of land, and fresh water fishing facilities have greatly expanded during recent years as a result of the construction of thousands of ponds and lakes. Deer and turkey hunting are generally totally lacking on lands in this class.

The extent to which small ownerships fit into the future development of public hunting and fishing depends largely upon the public itself. If property rights are respected and the sporting public shows consideration for the privileges extended it, small private ownerships should play a major future role in relieving hunting and fishing pressure on other classes of land.

LARGE PRIVATE OWNERSHIP

The seventy-six million acres of forest land in the large ownership class are between national forests and small ownerships as regards forest productivity and water conservation. The finest hunting in the South is to be found on lands in the large ownership class. Inasmuch as many tracts are managed by the owners at considerable expense solely for hunting, these lands are not open to the public.

Included with the large private holdings are industrially owned lands totaling about thirty-five million acres for which the paper industry accounts for twenty-one million.

Lands owned or leased by the southern paper industry are probably the most intensively managed forest lands on the continent.

Their present productivity is well above the level of the national forests. Beyond doubt these will be the first lands in the South to approach a condition of full forest productivity. They are administered by more than 1000 graduate foresters assisted by an even larger number of technicians and woodsmen. Company fire crews supplement state forestry crews with the result that fire losses are low. Timber harvesting is done according to prepared management plans and is carefully executed. As a result of this careful land treatment, conditions favoring water conservation are optimum.

More than 16 million acres of land owned by the paper industry are open to public hunting and fishing. A number of other industrial holdings, especially those owned by lumber companies, are also open to the public. On paper industry lands fishing facilities include ponds and lakes, some of which are several thousand acres in size. Boat launching ramps have been constructed on these lakes and also along streams flowing through company land. Dozens of picnic areas have been prepared and public response has been good.

By far the greatest public use of these extensive privately owned lands is for hunting. Good deer and squirrel hunting is available on many properties and turkey hunting is improving. Even on lands closed to the public there usually exists an understanding between the forestry personnel in charge and the local populace.

Upland bird shooting has become a thing of the past on most of the industrially owned lands. The woods are too thick for quail and woodcock, and the few farms that provided dove shooting in the past have reverted to forest.

It seems clear that the economic benefit to the community from lands in industrial ownership exceeds that for any other class of land. In the first place these are tax paying lands from the date of purchase deriving no benefit from homestead exemption or relief from any other taxes. It is not unusual for a corporation to pay its land taxes before they are due as a financial aid to local government.

The reforestation practices on paper company lands and others in large ownership are often intensive. At this very time several thousand workers are deriving temporary employment throughout the South establishing a new growing stock on widely scattered properties. The contribution to the local economy as a result is considerable. Payments are made for labor, gasoline, oil, repairs to equipment, machine rentals, and a host of others. It is no longer unusual for any of a number of paper companies to reforest fifteen thousand acres of idle or cut-over land every year.

Because paper companies are most interested in growing pulpwood which is an early maturing crop, bare land planted one year is the scene of forest harvesting operations eighteen to twenty years later. During this period land assessments generally increase thus adding to the tax revenue and the harvesting operations which follow provide the beginning of a new and permanent forest payroll.

The restoration of payrolls through reforestation on once idle lands by the paper industry is an established fact in various localities throughout the South.

Many rural families make daily use of roads on company lands. These roads aggregate thousands of miles for the entire region and were built and are currently maintained at no cost to the taxpayers.

The extent to which large land-owning companies are called upon to help finance community activities would stagger the imagination. The usual solicitation is, "Because you folks own so much land in our county, we know you will help." The call may be for an ad in a high school annual, a program for a rodeo or flower show, a contribution to Red Cross or March of Dimes, or to replace a church or school house destroyed by fire. In most instances the requests are granted.

But the greatest economic contribution derived from corporate land ownership is that providing a primary wood using industry for the community. When a lumber company erects a sawmill employing 75 people to process logs from its own land into finished products, the effect on the economy of a small community may be great. And when the paper industry, small in 1930, expands into one of the South's largest by 1960, the entire regional economy is affected. The bedrock on which the southern paper industry has been built is its forest lands. One of the first questions raised by bankers when asked to finance a new mill is, "How much forest land do you own?"

There is a feeling occasionally expressed that the paper industry is acquiring land to the detriment of the small owner. The fact is usually overlooked that the paper industry has acquired by far the greatest percentage of its holdings from other corporate owners, thus title has merely changed from one company to another. The percentage of land purchased from small owners is very slight. For example, a survey in Louisiana revealed that eighty-three per cent of the industry's forest lands was purchased from corporations, largely lumber companies long out of operation. Less than five per cent was acquired from farmers or other small owners.

In general the paper industry has purchased badly cut-over lands and reforested them at a cost beyond the reach of the average landowner. At considerable expense road systems have been built. Then three out of every four acres purchased have been opened to the public for hunting, fishing, and other forms of recreation. Certainly this is no discredit to the industry.

GENERAL REMARKS

From this superficial consideration of land ownership, it is apparent that each type has certain advantages and disadvantages to the public. But, to those interested in land management, it is also apparent that real progress is being made towards attaining full productivity on vast areas in the South. For some lands the primary object may be game management. For other lands the goal may be full forest productivity. For still others it might be recreation or water conservation.

Local changes of ownership will inevitably occur, but today there certainly seems to be no need to encourage either the hastening or retarding of these changes.

Clearly it would be impossible to provide public hunting grounds, facilities for water sports, and forest products for industry within a fifty-mile radius of every large town or city. There simply is not enough land. Groups interested in various types of land management and use must be reasonable enough to understand this fact. It should be recognized that no matter to what extent our future population increases, the total forest area will remain essentially what it is today.

There is need for continuous effort towards public enlightenment regarding land management. A long term goal of maximum production for some product or use should be set for land in all ownerships. Small landowners should be encouraged to develop at least a portion of their land for hunting and fishing on a daily fee or rental basis. Consideration might be given to tax concessions to large owners who open their holdings to public recreation. Special use agencies such as the military, including the Corps of Engineers, should be urged to limit their recommendations to a minimum when making demands on forest lands. Lastly, positive action should be taken to maintain a policy of multiple use for national forests. As a result our forest land under the present ownership pattern will be capable of providing the necessary products and uses most beneficial to the public.

GENERAL SESSIONS

Wednesday Afternoon—March 9

Chairman: RALPH W. STEEN
President, Stephen F. Austin State College, Nacogdoches, Texas

Vice-Chairman: JAMES B. ROSS
President, Nature Conservancy; Reinhold Publishing Company, New York City

---

MEASURES OF RESOURCE WORTH

WHERE WE STAND TODAY IN CONSERVATION

SETH GORDON
Vice-President, North American Wildlife Foundation, Sacramento, California

We have travelled far in our natural resource conservation efforts since the first of these conferences was held forty-five years ago last week. But we still have a long way to go!

By looking back over the trail occasionally we can determine where we have been, and where we should be going.

Conservationists as a group, and that includes administrators, have been notorious for their failure to "read the sign posts along the way," to study the record left by those who trod the same trails. Thus we have tended to repeat, over and over, the same foolhardy blunders.

So that we may evaluate "Where We Stand Today in Conservation," let's review the record of these and related conferences.

ROOSEVELT'S CONFERENCE WITH GOVERNORS

It is generally agreed that in North America President Theodore Roosevelt's conference with the governors of the United States at the White House (May 13, 1908), and his many official actions, were the kick-off for organized public conservation programs as we know them today. He told that first conference that:

> "The question of the conservation and use of the great fundamental sources of the wealth of this Nation is the chief material question that confronts us, second only to the great fundamental question of morality."

Roosevelt appointed a National Conservation Commission to inventory the resources in question, and a Conservation Congress was held in December of the same year, followed by a North American Conservation Conference in February, 1909—just before Teddy retired from the White House.

These conferences were held under official auspices, and included primarily high government and state officials.

Two of Roosevelt's biographers evaluated the impact of his actions as follows:

> "No policy of Roosevelt's administration excited deeper public interest or sharper opposition than his efforts on behalf of conservation. His official acts and the influence of his speeches and messages led to the adoption of a new theory regarding natural resources."

OTHER CONFERENCES FOLLOWED

Other natural resource conferences, held under civilian auspices mostly, soon followed. One series of five was called the National Conservation Congress (1909-1913).

The first of these conferences was held in Seattle, Washington, August 26-28, 1909. As one speaker at the opening session put it, this was "not a convention of officialdom, but a congress of the people." The arrangements were handled by the Washington Conservation Association.

Even though held under civilian auspices, the list of those present included high government officials, both state and federal, delegates high up in industry, banking, educational institutions, civic and conservation organizations.

Practically all of the states were represented, as was British Columbia. One might say, therefore, that this may well have been the beginning of the international cooperative approach in conservation matters.

"FOUNDATIONS OF OUR PROSPERITY"

The theme of those five National Conservation Congresses was: "Let Us Conserve the Foundations of Our Prosperity." Sounds familiar, a half century later, doesn't it?

While the major discussions dealt with industry and economics, and included such topics as forest conservation and the harnessing of rivers, the addresses also covered water pollution, soil erosion, fisheries conservation (especially the commercial fisheries), game protection, migratory birds, and numerous other topics we discuss today. Recreation and esthetic values were scarcely mentioned.

Other than foresters, led by Gifford Pinchot, technically trained workers in the conservation field then were unknown or unheralded.

The last of these National Conservation Congresses was held at Washington, D.C., in 1913, and according to the record attracted 1,400 delegates.[1]

THIS ACTUALLY IS 45TH CONFERENCE

While we call this the *25th North American Wildlife and Natural Resources Conference,* largely for "library purposes," it is in reality the forty-fifth of a chain of conferences, divided into two series, and continuous with the exception of the war year of 1945.

The first series of twenty-one conferences was held in New York City, under the auspices of the American Game Association (American Game Protective and Propagation Association, organized 1911).

The second series of twenty-five conferences has been sponsored by the American Wildlife Institute, organized 1935, and its successor, the Wildlife Management Institute.

The initial conference, under the name of the "National Conference on Game Breeding & Preserving," was held at the old Waldorf-Astoria Hotel, where the Empire State Building now stands, March 1, 1915.

In addition to discussions on game breeding, such topics as public hunting grounds, refuges for wildlife, protection for migratory birds, better sportsmanship, problems confronting landowners, improved fish and game administration, and the segregation of fishing and hunting license fees received attention. Number present at the banquet, eighty-two; all notables of that period.

The name of the conference was changed as the scope of its work was enlarged. After the third year it was known as the National Game Conference. Then after the fifteenth it was the American Game Conference, more fully to express its international character and scope. However, our Canadian co-workers were regularly present at the sessions long before the fifteenth.

Fisheries topics, water pollution, and forestry problems as they related to game and other wildlife, received their good share of attention.

---

[1]The other four of these congresses were held as follows: 2nd, St. Paul, Minn., Sept. 5-8, 1910; 3rd, Kansas City, Mo., Sept. 25, 1911; 4th, Indianapolis, Ind., Oct. 1-4, 1912; and the 5th, Washington, D. C., Nov. 18-20, 1913.

FEW TECHNICIANS THEN ATTENDED

During the early days of the American Game Conference technicians in the wildlife and fisheries fields were a scarce commodity. Several university professors who undertook special studies regularly attended to report their findings. Sometimes they brought a promising student along.

It was not until the 18th Conference (Dec. 1-2, 1931) that Dr. Arthur A. Allen of Cornell University assembled a handful of college-trained wildlife specialists in a comparatively small hotel bedroom "to talk shop."

This led to the three-day sessions we have long known, and the 19th Conference had its first special sessions on wildlife research. The attendance of technicians was very small, but administrators and others present quickly realized the need for trained fish and game men to collect basic information.

That same 19th Conference (Nov. 28-30, 1932) gave long-term fish and game program planning on the State and Provincial level its first real impetus. Ding Darling, a member of the new Iowa Fish and Game Commission proudly explained "Iowa's New 25-Year Plan." He also, with due modesty, announced the three-year cooperative research study at Iowa State College, to which he had pledged $9,000 of his own funds, which were matched by the Iowa Commission. This became the "pilot project" of the Cooperative Wildlife Research Unit Program, which I shall discuss later.

MANY PIONEER PROGRAMS EVOLVED

The first twenty-one conferences either initiated, or aggressively supported, some of the outstanding game and fish restoration programs and policies in vogue today.

Only a few of these can be mentioned, but among them were:

1. The 1916 Treaty with Canada to protect migratory birds.
2. The Migratory Bird Treaty Act of 1918, to give the treaty effect.
3. "The American Sportsmen's Platform," a comprehensive declaration of principles, adopted by the 1924 conference.
4. The Federal Waterfowl Refuge System, started 1920, enacted 1929 without the revenue and hunting grounds features recommended by the conferences.
5. The American Game Policy, adopted by the 1930 conference.
6. The Duck Stamp Law, to finance the federal waterfowl refuge system, regularly pushed by the conferences, enacted 1934, without the hunting grounds feature of the original bill.[1]

7. Federal Coordination Act, 1934.
8. The Pittman-Robertson Federal-Aid Program, enacted 1938, was initiated in 1931, as an alternate proposal for the Duck Stamp.[1]

THE CONFERENCES ON OUTDOOR RECREATION

At this point one should mention another series of conferences, started in 1924, concluded in 1928, because many of the active conservation workers today never heard of them.

President Calvin Coolidge appointed a committee of five cabinet members, headed by the Secretary of War, to plan a *National Conference on Outdoor Recreation.* Colonel Theodore Roosevelt, then assistant secretary of the Navy, was designated as executive chairman.

The purpose, as set forth in a report to Chairman Weeks, was:

> "The attainment of a balanced system of national economy . . . that will adequately provide for an optimum population . . . without lowering accepted standards of living . . . Outdoor recreation is the most wholesome expression of leisure and a needful social force . . ."

The first of these conferences was held in Washington, D. C., May 22-24, 1924, with 309 delegates representing 28 national organizations.

The conference functioned with a minimum of federal funds, but the cooperating national organizations each contributed about $250.00 annually. Funds also were raised by private subscription.

The initial conference adopted fifteen resolutions. They covered such widely diverse subjects as federal land policies, forest research and the relation of wildlife and recreation to forestry, wilderness areas, refuges for wildlife, water pollution and drainage damage, protection of migratory birds, etc. Some of the recommendations were shortly enacted into law.

Numerous committees were appointed and assigned work projects. Several of the participating organizations were assigned to make surveys. Of the latter, one of the most comprehensive was a report on "Recreational Resources on Federal Lands," intended to serve as a basis for national planning.[1] Another organization was assigned the task of making a survey of inland water pollution.

[1]At the 18th Conference (1931) an alternate proposal was made to impose a tax of one cent per shotgun shell (the tax to be rebated to registered target shooters) instead of the Duck Stamp, and to allocate almost half of the income back to the states for resident game work, the balance to be retained by the Federal government to finance the waterfowl refuge program of 1929. The Conference agreed to the appointment of a Special Ways and Means Committee, and to abide by its recommendation. The committee concluded that "a tax on ammunition, with an equitable division with the states, is the most feasible means of financing a big restoration program."

[1]A summary report of the surveys and projects undertaken by the National Conference on Outdoor Recreation was submitted May 3, 1928, and printed as Document No. 158, 70th Congress, 1st Session.

EVOLUTIONARY PROCESSES AT WORK

Evolutionary processes are always at work at these conferences. Long before the first series of twenty-one conferences had been completed there was widespread demand for steps which would elevate fact-finding, planning, and administration of fish and wildlife to the same professional levels as forestry and agriculture.

Except for a few colleges and universities, there were no opportunities for men to obtain training in modern fish and game survey and management techniques.

When Ding Darling, a layman and ex-fish and game commissioner of Iowa, became head of the U. S. Biological Survey in March of 1934, he decided to help do something about the deplorable shortage of trained men working at the state level.

After casting around for months he proudly announced during the summer of 1935 that an "angel" had been found to put up $30,000 annually through the newly organized American Wildlife Institute (now the Wildlife Management Institute); that the Biological Survey would provide $42,000 annually to employ the Unit leaders; that certain game departments would be willing to match the Institution's contribution; and that state land grant colleges or universities would provide facilities, etc. "to do research in wildlife subjects as well as in teaching the application of modern game-management methods." Ten projects were planned.

VIRGINIA GOT FIRST PROJECT

The response was magnetic. Virginia's Cooperative Wildlife Research Unit got off first, followed by Iowa, Oregon, Connecticut, Alabama, Utah, Texas and Maine, all underway by the end of 1935.

Since that time ten more units were added; one of the original units was disbanded, and one was taken over entirely by the state. Today there are sixteen cooperative units functioning, and the one maintained by a state.

To date there have been 808 master's and 121 doctorate degrees awarded. In addition, 2,283 bachelor's degrees have been conferred upon students who had training by the units, although not supported by them.

Today there are about 156 men being trained in wildlife work in the 16 units at the master's and doctoral levels; and approximately 54 are being trained in fisheries work, financed largely by state funds.

Since the first of these Cooperative Wildlife Research Units was initiated in 1935, the specialized conservation training programs have been stepped up and broadened at other colleges and universities. *But more training is needed in the field of fisheries management.*

NO DANGER OF OVER-SUPPLY

Is there any danger of an over-supply of well trained fish and wildlife graduates? The answer is: Definitely not!

In the beginning there was some fear that more men might be graduated from specialized courses in fish and wildlife management than would be absorbed. Fortunately, the Pittman-Robertson Program (1938) went into operation just in time to absorb the additional graduates, and the Dingell-Johnson Program (1950) came along in time to give fisheries trainees ample opportunity for employment.

The vast majority of the fish and wildlife graduates are in such work today. They are employed by state and federal agencies, teaching in colleges and universities, or working in closely allied fields. Many of them have attained high and influential positions in their chosen profession. More of them are going to the top of administrative conservation jobs every month.

These trained workers are bringing their findings to these conferences in increasing numbers annually, which assures a still brighter future for the North American Wildlife & Natural Resources Conference.[1]

PRESIDENT CALLED FIRST OF SECOND SERIES

I trust the summary of conference highlights prior to 1936, plus the supplemental information on the Cooperative Wildlife Research Units and the part they have played, will provide a glimpse of the major passing events.

President Franklin Roosevelt was induced to issue the call for the 1st North American Wildlife Conference, Washington, D. C., Feb. 3-7, 1936, to give the entire field of natural resource conservation new impetus. He said:

> "*My hope is that through this conference new cooperation* between public and private interests, and between Canada, Mexico, and this country, *will be developed . . . for the common good.*"

That conference attracted interested workers from all parts of the three countries, from every organization known to have an interest in the conservation of all natural resources, especially forests, waters, soils and fish and wildlife.

---

[1]The Cooperative Wildlife Research Units were established at the following educational institutions: Auburn University, Alabama, Oct. 1935; University of Alaska, Mar. 1950; University of Arizona, Nov. 1950; Colorado State University, Oct. 1947; Univeristy of Connecticut, Sept. 1935 (disbanded 1937); University of Idaho, Nov. 1947; Iowa State University, Sept. 1935; University of Maine, Dec. 1935; University of Massachusetts, Sept. 1948; University of Missouri, Nov. 1937; Montana State University, June 1950; Ohio State University, Apr. 1936; Oklahoma State University, Feb. 1948; Oregon State College, Sept. 1935; Pennsylvania State University, Feb. 1938; Texas A & M College, Dec. 1935 (operated on state funds since 1954); Utah State University, Nov. 1935; Virginia Polytechnic Institute, Sept. 1935. Total graduates from these institutions with wildlife management training, 3,212. See page 7, Dec. 1935 Field & Stream Magazine, for list of 40 colleges and universities then offering courses in the wildlife field.

The conference ran for five days, one of which was devoted to planning the organization of the National Wildlife Federation, with the thought of having a central clearing-house for all of the local organizations throughout the country interested in the broad field under discussion.

The addresses and discussions covered practically every conceivable phase of our natural resource problems. The printed proceedings covered 675 pages.[1] Seven related meetings were also held.

This was the greatest public forum of its kind that had ever been held in North America. It was a conference in which no commitments were made, other than to give birth to the National Wildlife Federation.

A QUARTER CENTURY OF PROGRESS

The history of the past twenty-four conferences is pretty well known to most of you here present. The record of progress is a most impressive one.

By moving the conferences to various regions of the United States and Canada it has been possible for many more people to attend them, and to get the necessary information and inspiration with which to make a mass assault upon the problems in hand.

It has been a quarter century of progress, of understanding, of cooperation.

Many of the problems which confronted us twenty-five years ago have been solved, or are on the way to solution.

"THE TEST OF OUR DEMOCRACY"

The informed peoples of the three Nations regularly represented in these conferences are fully cognizant of the warning Wisconsin's Governor Walter J. Kohler gave us at Milwaukee in March 1951, when he said:

> *"Nations disintegrate through the loss of natural resources . . . The real test of our democracy will come when our resources begin to run out."*

They also have learned that no nation can develop a balanced economy by destroying or wasting any of its natural resources; that by proper advance planning fish, wildlife, and recreational programs can be fitted into forestry, water development, agriculture, and industry; and that as Nations they must cooperate fully on international problems.

[1]A Committee Print of the Special Senate Committee on Conservation of Wildlife Resources, 74th Congress, 2nd Session.

IMPACT OF THESE CONFERENCES

Largely due to the impact of these annual conferences, and the opportunity for those in attendance to obtain the latest information on improved methods and programs, the conservation programs in Canada, the United States, and Mexico have been greatly advanced beyond what they were when we met in Washington in 1936.

In the United States the wildlife and recreational programs are finally getting the attention they deserve on the National Forests and other public lands (and with 81,500,000 visits on them last year, an increase of 19%, mostly in the undeveloped areas, it's high time we do something about it); the national parks are being reconditioned and materially expanded facilities are being provided to keep up with the public demands for such recreational opportunities; water pollution control and abatement programs have become a MUST on the part of an aroused public; the waterfowl restoration program is being stepped up nationally and within the states; the two federal-aid programs are a great boon to the states; the soil conservation job being performed in many states has done miracles; small watershed programs are putting flood control where it belongs; fisheries research and management programs are being advanced; a new national recreational resources survey is underway; and finally we are taking a serious look at the pesticide and poison spray situation. A simple household commodity like cranberries has certainly aroused the public!

AN OCCASION FOR CELEBRATION

We still have many problems to lick, notwithstanding the progress we have made. Among them are such items as stopping the drainage of the prairie potholes under the guise of aiding agriculture; better control of devastating forest fires and protection of watersheds; how to handle the synthetic compounds and detergents in our sewage treatment plants; recognition of the use of water for fish, wildlife and recreation as a beneficial public use in all states; and many others.

But this 25th North American Wildlife and Natural Resources Conference is an occasion for a celebration, not one for lamentation about the things yet undone.

One of the things I like best about the conference is the additional recognition of the broad field of "natural resources" which the conference title now bears.

Another is the fact that the conference program is largely dominated by the young, well-trained workers. They are no longer the minority we knew back in 1936. And instead of seven related meet ings as we had in 1936, we now have dozens of them.

Probably one of the highest tributes of all came to me recently from Karl T. Frederick, one of the participants at the very first conference in 1915, who said:

> "I think *one of the most important lessons* that was learned from the conferences (and I am sure he meant both those sponsored by the American Game Association and the Wildlife Management Institute) *was the need of honest cooperation among different groups in so far as their consciences would permit.*"

Ladies and gentlemen, with the "cross-fertilization of ideas" that regularly takes place at these big international gatherings, I am confident that we will continue to have "honest cooperation," and that future conferences will be equally effective and productive.

DISCUSSION

DR. CLARENCE COTTAM [Texas]: I used to be with the Federal Service. I would like to ask Seth to project the thinking that he has so ably given us, and may I compliment him on an excellent paper. He mentioned the Coordination Act and how effective that was in 1934 and its later amendments, and he better than most of us, remembers some of the struggles that we went through in order to get some of those amendments.

We have referred to it on a number of occasions, and I have had a couple of occasions to refer to the idea of strengthening the Coordination Act, that we had to develop to protect wildlife interest in the field of engineering. I am personally of the opinion we have to do something in the same manner in the line of pesticide use and the detergents. Maybe we have reached the point where another Coordination Act needs to be inaugurated that will carry these other aspects. I would like to see if Seth has any comments on it. It seems to me in thinking ahead we might just project this idea a step forward.

MR. SETH GORDON: Dr. Cottam and Ladies and Gentlemen: Some people aren't going to like what I say, but I think there is just as much urgency and just as much need to extend the Coordination Act to cover this field in a way that will not necessarily curb the activities of the Department of Agriculture, and its subordinate units, but so that there will be some clearance, some understanding, some cooperation in advance of some of the things that are done.

Now I know there are emergencies in which we have outbreaks of various kinds, and something has to be done quickly, but we should not depend entirely on the states to fight their own battles. The Coordination Act could well be expanded to cover that situation in such a way that it would not upset anybody.

CHAIRMAN STEEN: Before introducing the next speaker, I should like to give Mr. Gutermuth an opportunity to make an announcement.

MR. C. R. GUTERMUTH: Thank you, Dr. Steen. Friends, while we ordinarily do not do this sort of thing, we thought it advisable to make some brief comment about two very unfortunate pieces of news that have come out of Washington today. First, is the report of the untimely death of Richard Neuberger of Oregon. Senator Neuberger has been called on the floor of the Senate upon many occasions one of the leading conservationists of this country. He was a good friend, a very young man, a man whom we always could rely upon to be in the forefront on every battle, and I think it is most unfortunate and a very serious loss to us conservationists.

The other bit of bad news is a report that was telephoned to Dave Brower at the Sierra Club by Congressman John Saylor of Pennsylvania, another one of these staunch conservationists.

This is exceedingly bad news, too. In the successful battle on the part of the conservation forces of this country to prevent the building of a dam in Dinosaur National Monument and in the subsequent enactment of the Upper Colorado River Storage Project Bill, provision was written into that legislation which said that the Rainbow Bridge should be protected. Now Secretary Seaton has upon occasion and within the last two weeks assured me that it not only was his wish but that he was going to do everything in his power to see that Rainbow Bridge was protected in the building of the great Glen Canyon Dam in the Colorado.

The report from Mr. Saylor is that the House Appropriations Committee has decided against putting in any money for protective devices that are needed to keep the water backed up by the Glen Canyon Dam from flooding the canyons up to and under Rainbow Bridge.

I am not going to use this dais for rabble rousing, but I am going to say this —that when we can find ways to appropriate millions upon millions of dollars for every conceivable thing around this world, certainly there ought to be some way in which we can find a way to protect one of the greatest natural phenomena in this world, Rainbow Bridge, and I hope the conservationists find some way of expressing themselves on matters of this kind. Thank you, Mr. Chairman.

CHAIRMAN STEEN: I won't call any names, but someone proposed a while ago that if we moved that bridge to Yugoslavia we would have no trouble protecting it.

THE ECONOMIC VALUES OF CONSERVATION[1]

ORIS V. WELLS
Administrator, Agricultural Marketing Service, U. S. Department of Agriculture, Washington, D. C.

There is a widespread belief that the economic scarcity of resources today impairs economic growth in many areas and threatens far worse for the future. There are in fact some who seem to feel that somewhere, somehow, the Malthusian dilemma—that is, "the constant tendency in all animated life to increase beyond the nourishment prepared for it"—will become so real as to force the end of civilization as we now know it.

I suspect that none of us agrees with this second or extreme view of the "population-resources-standards of living" problem. Nevertheless, we can still safely say today, as someone did say so far ago as 1910, that "A great many people are in favor of conservation, no matter what it means." But the problem of this session, as I understand it, is to ask "What does conservation mean?" or, alternatively, "Why are we so interested?"

You of course know that economists today are not wholly agreed as to the values of, or the rationale underlying, the conservation movement despite the fact that they once were, as many of us still are, much concerned over the constant struggle between technological advance and substitution versus the law of diminishing returns. For example, one very able economist recently said:

> "A larger economy should be more efficient than a small economy; this has been the standard view of economists since the one important disadvantage of the large economy, diminishing returns to natural resources, has proved to be unimportant." (George Stigler, Conference on Income and Wealth, National Bureau of Economic Research, October 17-18, 1958.)

This is not an isolated view; other economists make similar, if more guarded statements. Nor is it wholly confined to the United States where we have been able to successfully defer the law of diminishing returns for quite a long time now. However, I would not want you to think that this view derives simply from historical analysis; rather, it seems to me that it traces in large part to our physical sci-

[1]I am indebted to Harold J. Barnett's most interesting "Malthusianism and Conservation—Their Role as Origins of the Doctrine of Increasing Economic Scarcity of Natural Resources," *Reprint Number 12*, Resources for the Future, Inc., March, 1959. I have also drawn on (1) the introductory article by Joseph L. Fisher, "Resource Problems and the Social Sciences," *Annual Report*, Resources for the Future, Inc., 1956, and (2) my own earlier paper, "Economics and Conservation, Some Preliminary Comments on the Forces Conditioning Conservation of Renewable Natural Resources under Conditions of Economic Progress," *Proceedings of the Inter-American Conference on Conservation of Renewable Natural Resources*, Department of State, 1948.

entists many of whom seem to believe that they can indefinitely maintain current rates of technological advance, provided they are given adequate support.

Economists generally, or so it seems to me, neither fear the Malthusian dilemma nor look upon the natural resources problem as unimportant. Our chief interest is in what our friend Joseph Fisher (currently Director, Resources for the Future) terms "resource development"—that is, with so ordering our actions as to approximate "the maximum *sustained* contribution from [our natural] resources to the increased . . . production of goods and services, and in the resulting income; this to be achieved at the least feasible cost."

But just as mathematicians have found it necessary to go far beyond the ideas which can be expressed in terms of simple, rational whole numbers, so have economists or, more precisely, social scientists found values and problems in the conservation field which go far beyond (a) the idea of *maximizing the sustained yield of particular natural resources,* and (b) the correlative idea of *minimizing economic waste* in the use of our natural resources and their products.[2] Increasingly we are concerned with the problems of ecological balance, with the idea of conservation as an insurance factor, and with our newest natural resource problem (at least so far as the United States is concerned), the conservation of space itself.

One of the simpler statements of the ecological balance concept is that "The human race depends for its existence on renewable natural resources—water, soil, forests, grasslands, and the complex biological web that unites them, makes it possible for them to exist, and maintains them in a balanced relationship." Note that this statement turns around the term *"the complex biological web."* This term surely represents a relevant and most significant part of the ecological concept. But any really useful or valid discussion relating to conservation of renewable natural resources must also consider an equally complex economic and cultural web, which significantly alters and conditions the manner in which biological balances are achieved and maintained.

[2]Barnett distinguishes *four types of waste* which conservationists generally desire to minimize. One type is destructive utilization of a natural resource where it would be possible to procure about the same kind of product or service by non-destructive use of that resource, of a renewable resource, or of another, more plentiful resource. The second type is failure to procure the maximum of sustained physical yield of useful extractive products from nature's renewable resources. Essentially the first type of waste includes over-exploitation of renewable resources to the point where their capacities are reduced; this second type of waste is under-exploitation. The third type occurs from practices which generate scarcity through mismanagement of non-renewable resources. For example, waste occurs with respect to mineral resources from failure to maximize the yield of extractive product from the physical resources which are destroyed. The fourth type of waste with which conservation is concerned, no less productive of scarcity than the others, results from unwise or non-economic use not of the natural resource itself but of the extractive products yielded by it.

Waste is always remedial but in the practical world consideration also must always be given to what the remedies cost.

That is, under "natural" conditions, or conditions which existed over most of the more temperate areas in the Americas prior to the development of intensive cultivation, grazing, and forest cutting, we usually assume (perhaps correctly, perhaps not) a relatively stable biological balance existed. An advancing economy, however, means that the renewable natural resources of an area must be more and more intensively used. There is no alternative.

But the increasing use of renewable natural resources in an advancing economy sets off a whole new chain of events—a chain of events which often forces the area concerned into a *transition stage,* characterized by unwise land use and deterioration of the soil, the forage, and the forest cover; which renders any return to the original biological balances impossible over any wide area, both for economic and biological reasons; and which can only end in the impoverishment not only of the resources but also of the associated human culture, unless a new series of balances is reached—*balances which,* to restate Fisher's definition of economic development, *will approximate the maximum sustained yield of desired goods and services, at the least feasible cost, within a stable economic and cultural environment.*

Whether you hold with the older, simple time-preference idea of conservation—that is, it is our "clear duty . . . to watch over, and, if need be, . . . to defend, the exhaustible natural resources of the country from rash and reckless spoliation (A. C. Pigou)"—or the newer or more sophisticated ideas of resource development within a complex ecological and cultural web as a means of actually *increasing the yield and productivity* of our natural resources, the very concept of use introduces some real difficulties—difficulties which call for some modification of the strict "laissez-faire" doctrine around which our economic system is chiefly built.

Simply because farmers, businessmen, or others exploit the particular resources at their command or fail to take action which would seem to be in their collective interests, it does not by any means follow that they are unwise, their own immediate economic interests considered. This brings us to the consideration of (a) differences between the short-run and long-run interests of the same individual and (b) differences between the interests of particular individuals and what we generally refer to as "the public interest." It is these differences, of course, which bring government into the conservation field, along with the fact that from time to time in our enormously complicated technical and economic world government alone seems able to venture the capital or take the risks involved in some of the activities basic to increasing the productivity of the resource base. The only further comment I want to make with respect to governmental intervention is to say that education and economic incentives are as a rule far more effective than compulsory measures. True, compulsory measures are sometimes necessary but even then they will work only after research and education have gone far enough so that such measures are generally understood, agreed upon, and actively supported by the great majority of the individuals concerned.

I mentioned earlier that conservation has an insurance value. It seems to me that this needs little elaboration, especially with the current acceptance of the view that we have a long continuing population increase ahead of us. Perhaps the scientists will be so continuously successful decade after decade, generation after generation, that our worry over diminishing returns and rising costs will prove groundless, perhaps not. We simply don't know. And the problem is further complicated by the fact that it is also possible for science to reverse itself; to destroy rather than to create. Should we ever find ourselves forced back toward the simpler life, good land, flowing streams, and a plentiful supply of timber would still be worthwhile.

Now, in conclusion:

I have turned my back as firmly as I know how on the idea that man is a "social cancer."

I have said that economics sees great possibilities in sustained yield resource development as a means of promoting economic growth and human welfare.

And, finally,

I have briefly mentioned that some economists at least are much concerned simply over the conservation of space itself. To give you a better idea of what this is, let me end with a brief quote from one of the great masters of political economy which seems to me far more pertinent today than when it was first written a century or more back:

> "A population may be too crowded, though all be amply supplied with food and raiment. It is not good for man to be kept perforce at all times in the presence of his species. A world from which solitude is extirpated is a very poor ideal. Solitude, in the sense of being often alone, is essential to any depth of meditation or of character; and solitude in the presence of natural beauty and grandeur, is the cradle of thoughts and aspirations which are not only good for the individual, but which society could ill do without. Nor is there much satisfaction in contemplating the world with nothing left to the spontaneous activity of nature; with every rood of land brought into cultivation, which is capable of growing food for human beings; every flowery waste or natural pasture ploughed up, all quadrupeds or birds which are not

domesticated for man's use exterminated as his rivals for food, every hedgerow or superfluous tree rooted out, and scarcely a place left where a wild shrub or flower could grow without being eradicated as a weed in the name of improved agriculture." (John Stuart Mill, *Principles of Political Economy,* Longmans, Green and Co., London, New Edition, 1929, Book IV, Chapter VI, p. 750.)

DISCUSSION

VICE CHAIRMAN ROSS: I might attempt to point one direction here in that I think this is no longer a matter of prediction as to whether or not we are going to diminish some of our resources. There are many of us from very highly populated parts of this continent who feel perhaps we have already exceeded anything that anyone might consider an ideal ratio between space and human beings.

CONSERVATION FOR MORE AND MORE PEOPLE

JOSEPH L. FISHER,
President, Resources for the Future, Inc., Washington, D. C.

There are two sides to the proposition, "conservation for more and more people." That there will be more and more people in the decades ahead seems now to be a virtual certainty. That there will be adequate resources conservation, however that is determined and measured, seems much less certain. My concept is that conservation means the optimum rate of development and use of those parts of the natural environment we call natural resources to meet important needs. Frequently a long-term and social point of view must be taken. Conservation is not the locking up of resources; rather it means the unlocking of resources potentialities to enable people to live more satisfying and constructive lives. Sometimes this means development and use, and even using up of a resource; other times it means preservation intact; more typically it means a rational rate of use over periods of time which will vary with the resource in question and with differing views as to what services are desired from the resource. Throughout, fundamental ecological constraints must be respected.

Conservation, in another sense, is the policy of prudence, of care, of conservatism—conservatism not so much in the political sense as in the intellectual and attitudinal sense. Curiously, conservation has advanced most significantly over the last half-century or so during periods when progressive administrations have been in control in the national government: during the period of Theodore Roosevelt and Gifford Pinchot and the progressive Republicans, and during the period of Franklin D. Roosevelt, Henry Wallace, Harold Ickes, and the progressive Democrats. One reason conservation has had its more significant advances during times when progressives have been in power is because the progressives have been more willing to use the power of government to advance conservation programs.

With the future necessarily uncertain and not becoming any less so, even with the remarkable gains in science and technology and in economics and the social sciences, prudence argues for rigorous policies and actions for conservation of topsoil, water, minerals, wildlife, fish, natural scenery, and fresh air. A rich country such as this one is fortunate: it can easily afford to maintain and build its resource capital through conservation. Poor countries, like poor people, have a much harder time and frequently have to deplete their resource capital to live.

Let us look in a little more detail at the two sides of the issue, "conservation for more and more people." The term, "population explosion," has entered into the general vocabulary with strong assistance from books, magazine articles, and pamphlets, from TV programs, from statistical compilations of the United Nations, and even from direct observation of the increasing number of world travelers. One of the great facts for this world in the mid-twentieth century is the rapid rate of population increase and the widespread awareness of this. In the western more developed countries, the last fifteen or twenty years have seen a considerable rise in birth rates, which has been sustained and shows no immediate clear sign of falling. In the less developed and more populous parts of the world, the last few decades have seen remarkable decreases in the death rate with the wide application of public health measures. At the same time birth rates have fairly well held up in most of these countries, although many population experts expect they will begin to move downward in response to such factors as the increasing use of birth control measures, increasing levels of living, increased urbanization, and others.

A generation ago during the depression of the 1930's, the outlook was altogether different, and many demographers were projecting a stable population for the western countries before the end of the twentieth century. Now the shoe is on the other foot, and most demographers are quite hesitant about specifying any ceiling to population growth. Not counting the calamity of major war, it seems likely that world population, now increasing at about 1.7 per cent a year will be at least twice as large in 2000 as the present figure of around 2.8 billion. This growth apparently will not be even over the continents of the world. The prospect is for the most rapid increase to occur in Central and South America, with Asia, Africa, North

America, and Europe following in that order. In absolute numbers of people, Asia will exceed all the rest of the world put together by 2000 and may have some four billion people out of a world total of more than six billion.

In our own country by 2000 we may well have on the order of 330 million people, producing a gross national product of better than $2,000 billion (more than four times the present amount), and yielding a level of living more than twice as high as that now enjoyed by the average American family.

Turning now to the other side of the proposition: what are the prospects for feeding, housing, and otherwise providing for the tremendously increased world population of the year 2000? This looks like a staggering job, and it will be in many parts of the world. The contrast between the economically more developed and economically less developed countries is sharp. In this country, for example, it seems reasonably clear that barring war or other catastrophe, living levels can go on increasing at least through the end of the century so far as the availability of basic natural resources and raw materials are concerned. The history of the past 75 years or so in this country does not indicate that we have been running out of basic materials, or even that they have been increasing in real cost very much. The performance on this score has been mixed: forest products as a category have increased considerably in relative price and cost; agricultural commodities in general have increased somewhat, although in part this may be due to particular policies that have been pursued; while minerals as a category have for a long time remained about stationary in this regard. While these long-term price and cost trends provide no absolute guarantees against general shortage of raw materials in the future, they are a kind of assurance of a strong likelihood that what has held for seven or eight past decades will continue to hold for a few more.

The resource problem is eased by virtue of the trend which seems certain to continue in which the raw material component of the total national production is diminishing. Employment in resource industries expressed as a per cent of total employment is also likely to continue to fall. Capital in many forms will continue to be substituted for labor in agriculture, mining, forestry, water development, and the other resource industries. Beyond this, reliance upon imports of many raw materials may be expected to continue to increase, the extent and nature of which will be greatly influenced by foreign trade policy and international policy generally. Already this country imports large amounts of such important materials as oil, iron ore, copper, bauxite, pulpwood and pulp, sugar, and coffee.

In its technologic and economic evolution, this country has passed from a close dependence on basic resources, such as agricultural and forest land and mineral ores, to one geared much more to highly processed and variegated intermediate and final goods and to services. As the range of possible substitutions is broadened and more has become known about the chemistry of raw materials, dependence on any one material has lessened. Molecules can now be rearranged and things produced to specification in an astonishingly large number of instances. Furthermore, techniques for conservation and re-use of materials are improving.

In short, the prospect for this country is that enough basic raw materials will be available through the remainder of this century to make it unlikely that economic growth and improvements in level of living need be restrained on this account. This seems to be in prospect even though the absolute amount of most of the basic raw materials required by the American economy in 2000 will increase greatly. Of course, there will be numerous specific and very difficult problems, such as enough fresh water in certain places, enough outdoor recreational opportunities well located with respect to population centers, enough fish and game for sportsmen in desirable places, enough of certain metals at certain times, and so on. These problems will require most careful analysis and prescription.

None of these comforting projections for the future will hold true unless we maintain a strong general educational system, vigorous programs in science and technology, a reasonably smoothly working system of international trade and investment, many kinds of business and governmental policies which will favor resource development, and a well-devised broad program of resource conservation. These won't happen automatically; they take the hardest kind of thinking and work on the part of many people.

Turning to other parts of the world, especially the less developed parts, these reassuring outlooks may not hold. The contrast is sharp; their problems are full of difficulties and complexities the resolution of which is important not only for the countries involved but for the whole world. Countries like India and Mainland China are on a much less advanced technical base and will find it difficult to sustain a take-off into continued economic growth. Populations increase there inexorably and threaten to gobble up whatever gains may be made through saving and investment, development of resources, transportation, and industry. It is essential for such countries that the rate of investment be sufficiently high that they can keep ahead of the elemental demands of more and more people. Beyond this, and in my view more difficult still, the higher rate of investment must be directed skillfully to those kinds of developments which will multiply yet further investment, rather than peter out quickly in the form of unproductive activities and economically and socially useless equipment. These countries will have the most trouble in pursuing conservation activities on a broad front. By the nature of their situation it is much harder for them to take the long view, to save in favor of their children and grandchildren and refrain from present consumption.

Returning now to the proposition of conservation for more and more people, there seem to be several points at which policy and action may have decisive influence on the outcome. In the first place, a direct approach through family planning to the problem of high birth rates must be mentioned. This is a complex and controversial subject, not as regards general objectives, but as regards means. I shall not go into this subject beyond expressing my belief that as knowledge of the subject increases and as communication among the different groups improves, there ultimately will be found agreement on the question of means.

The rate, choice, and scheduling of investments for resource and other forms of economic development are of critical importance everywhere, but especially in the less developed countries. Here the state of knowledge is not what one would like. The question is difficult; the kinds and timing of investments that will lift one country most rapidly on its way to economic development are different from those required in other countries. Frequently the needed investments cannot be financed as readily as less needed ones. Shortage of foreign exchange in many of the less developed countries is a major obstacle. The precise role of financial aid from the wealthier countries frequently is difficult to define because it is involved with military consideraations. One can hope that, as more experience in economic development become available, it will be possible for the economists and the social theorists and planners to furnish to the engineers and developers a better and more helpful picture of what exactly is going on.

Very important also is the maintaining and extending of a reasonably free world system of trade, investment, and economic flows generally. In this way it becomes possible for a country to look elsewhere in the world for a solution to resource and other obstacles to growth. If the world becomes compartmentalized into several large political-economic blocs with little trade among them, or, worse, into numerous small national boxes, the problem of keeping ahead of population growth in many places will become almost insurmountable.

Basic to any strategy for maintaining or increasing economic growth and levels of material welfare are those very basic choices which national groups make, explicitly or implicitly, regarding what they want to do with increasing productivity. Professor Walt Rostow of Massachusetts Institute of Technology recently has delineated several basic options for technologically and economically mature countries like the United States: expansion of mass consumption, more leisure time, more social welfare, more military strength and power, and more economic growth for the future. Many observers think that the Soviet Union is opting mainly for economic growth in the future, while the United States seems to prefer greater consumption now. If this is true and continues, a very difficult and bleak future would seem to be in store for this country.

But to return to the matter of resource conservation, it may be ventured that conservation has an important role regardless of which of Rostow's options is chosen. If the future is to be one principally of more and more consumer goods and services, conservation will be important. Increases in food consumption a generation or two from now may rest importantly upon soil and water conservation activities being pursued at the present time and in the near future. Large numbers of industrial plants, houses, and consumer durables, not to mention gadgets, will require increasing amounts of metals, lumber, and other raw materials. If we opt for leisure and welfare, then conservation of open spaces; park, recreation, and wilderness areas; fresh water for sports; and clean air will all be of major concern.

If a country chooses military power as its main objective, again conservation has its role to play because military power is still related to adequate protectable supplies of fuels and of hard goods and materials of many sorts. And finally if future economic growth is the main thing, then this too will have to rest upon an increasing flow of basic resource materials of iron ore, water, coal, lumber, and many others.

The importance one attaches to conservation, whatever path is chosen, depends very much on the length of time ahead one is considering. I have said that this country should have enough raw materials through the end of the century, but I say nothing of the period way out beyond that. Looking a century or more into the future little can be seen clearly for this or any other country, but the experience of ancient Mesopotamia, Lebanon, and Greece is impressive and counsels a policy of conservation as a matter of national survival insurance. Economic calculations are of limited use for this kind of time period; they are much more appropriate for weighing the merits of shorter-term courses of action when the alternatives are more or less similar, and therefore comparable, in their economic effects.

Pursuit of conservation requires that the individual be able to project himself far into the future to his old age and into the lives of his sons and grandsons. It also requires that he project himself outward into his national society and the world. In the narrow short-term view, the case for conservation is seldom compelling; in a longer view and wider horizon it may be overwhelming.

How ardent a person is for conservation depends much on his view of the race between the *increasing costs* and the *technologic advances.* Unfortunately the odds on this horse race aren't posted, so each person must place his bet according to his own analysis and feel of the total situation: he must take into account the skill of the jockeys, the stamina of the horses, and the condition of the track.

My own preference is to view conservation as a matter of prudent insurance against a risk—a risk not of running out of resources, but of needing more than we may be able to get at reasonable cost. I would have us carry a fairly sizable insurance policy with heavy annual premiums in the form of soil and water conservation expenditures, fish and wildlife restoration, research and development to reduce waste in the extraction and processing of minerals, and so on. The national estate must be kept in tiptop condition and not allowed to run down. Especially the basic and general resources—the land itself, topsoil, surface and underground water, forests, minerals, the air—should be maintained and, where feasible, developed and improved to provide both their time-honored and their newly found services to society. The time-honored ones include food and clothing, shelter, manufactures of all sorts, and recreation and inspiration. Among the newly found are atomic energy, fresh water drawn from salt or brackish water, artificial rainfall, minerals extracted from sea water, new uses of solar energy, and deliberately induced genetic variations.

Since there are to be more and more people, conservation in natural resources becomes more insistent as a matter of prudence and common sense. At the same time the development of them in broadest terms becomes equally imperative to meet increasing needs. In the immediate situations, balances will have to be struck between developing and not developing, between using now and using later, between using more and using less—and decisions will have to be made by governments, economic groups, and individuals. The way the stream of these decisions flows will determine the degree and kind of conservation we shall have.

DISCUSSION

VICE CHAIRMAN ROSS: Mr. Fisher has as usual given us a very knowledgeable and clear analysis of the situation as he sees it from the standpoint of conservation economics, if I may use that expression.

DR. WALTER P. TAYLOR [U. S. Department of the Interior, Retired]: I have been very much interested in Mr. Fisher's paper. It seems to me he had a slightly

Pollyanna attitude, a bit ultra-optimistic in the matter of the conservation of these natural resources of ours and of our immediate present and future status. As far as maintaining and vastly increasing perhaps doubling the standards of living as he suggested by the year 2000, I have personally some rather grave doubt.

I wonder if Mr. Fisher would go so far as to suggest that the confidence he apparently has in the scientists would justify relaxing somewhat our regulations and our activity in the matter of soil and water and forest and grassland and wildlife conservation. I wonder what we can do in Southern California, for example, where we have people coming at the rate of several hundred a day, where it is anticipated before many years our agricultural land will be completely covered with matchbox houses, from Santa Barbara to San Diego and for a space of some 50 miles inland. How are we going to keep even now the clean air for which we thought we were entitled?

How are we going to get space? Mr. Fisher suggested we are not running out of resources, but I suggest in some places certainly we are definitely running out of some of the most important resources—clean air and space among them. You will remember no less an authority than Dr. Paul D. Sears has suggested that those who talk about a constantly expanding civilization such as we do all the time in the United States are really speaking in terms very similar to those that talk about perpetual motion, that the idea of expanding an economic organization such as our Western civilization on the basis of a constantly contracting base of natural resources seems to Dr. Sears, and certainly to me, to be out of line with good reason and common sense.

Whatever else may be said, it does seem to me that if the ultra-optimistic view which apparently was expressed by Mr. Fisher prevails, a good deal of the activity of organizations and conferences such as this is certainly unnecessary if we can leave all this to the powers and the performance of our scientific leaders. They are wonderful, and we shouldn't discount them, and there is no reason why we should, but it does seem to me whatever we do, we should not permit the accomplishments of our scientific civilization to keep us from saving all we possibly can of our soil and our water and our forest and our grassland and our wildlife and our space and our clean air.

VICE CHAIRMAN ROSS: Thank you, Dr. Taylor, I am very pleased that you raised this aspect of the question. I find that personally I agree with you very largely on this point of view, and Mr. Fisher, would you like to comment on this question?

MR. FISHER: Yes, I would.

I definitely do not think that conservationists should rest on their oars or relax in any sense. I think there is much work to be done in many places, and it will take the best and hardest work of all of us conservationists to keep up with things. I do not think, however, that the motivation for hard and careful work should be fear of shortage or running out in the foreseeable decades ahead. I think the motivation should be different altogether. It should be the positive one of economizing in the use of resources and materials, of managing them well and sensibly, of having the most profound respect for ecological principles and balances and systems.

This is my point of view. I recognize, of course, in certain places there will be most serious problems. Most of my remarks were in terms of the nation as a whole within which there are many opportunities for substitution of more plentiful materials for scarcer ones, and I guess it is all right to say in Texas that really not all those people have to go to Southern California. [Laughter]

VICE CHAIRMAN ROSS: Thank you, sir. I think it is quite important as I mentioned a while ago, some of us who come from the more populated regions feel we have already exceeded this point of diminishing returns on space, and we feel a little bit now like chickens with plenty of water and food before us, but we are losing our feathers just by rubbing up against each other.

I think we have another gentleman with a question.

DR. SWANSON [New York]: I would like to ask the speaker if there might not be a better way of measuring the standard of living, which to most people has a connotation of the better life.

You spoke frequently of how our level of living is likely to improve, and when we speak in those terms it's always material things. The gross national product is increasing. The per capita telephones, television sets and automobiles are increasing, and this is the traditional interpretation of improvement of standard of living, but isn't there some other way that we could measure what seems to me a much more true situation, actual improvement of life, the better life? This would necessitate the use of other things than material things.

I think that is what many of us in this room are concerned with. The emphasis on material things is disconcerting and can lead us astray, I think.

MR. FISHER: I couldn't agree with you more that the things that perhaps many people regard as making up improvements in the level of living may be trivial and unimportant and even detrimental to what a philosopher or a religious leader or somebody else would regard as improvements in the quality of living.

The economist, frequently because of the way he measures things and the things he measures, may not give full accounting to the importance of the intangibles in his measures of national product and national income and the average income and so forth, but he doesn't overlook them altogether by any means. For instance, as a person I would advocate and did in my paper larger expenditures for various conservation activities for the provision of parks, the management of fish and game and so on.

Now these expenditures are counted in the national income and in the average level of living just as much as are the expenditures for automobiles with their high and absurd tail fins. So I do want to bring out the point that the economist does not overlook them. They, too, are included to the extent that we are able to spend typically through public budgets for these things, and as a person I would and frequently do advocate more attention to these matters, so it isn't quite so simple as saying that the economist doesn't take them into account. He does, and the way he takes them into account is precisely the way we as citizens vote them into account by our budgets.

VICE CHAIRMAN ROSS: Thank you, gentlemen.

As a local note, arriving here on Saturday, coming in from the airport in the taxi cab I learned that the byway out here known as—I think it's referred to as Turtle Creek. Progress is coming upon Turtle Creek, and they are talking about a 6-lane highway. There are 800 beautiful trees along Turtle Creek, and I think all of you have been here long enough to realize a beautiful tree is a very valuable commodity in the Dallas area, and yet progress being as important as it is, the local people who are thoughtful about these things are very much in fear they are going to lose their trees and gain more concrete.

They are quite proud of their beautiful buildings and clean air. In this respect they fortunately don't have a heavy industry to threaten the air at this time. I wonder how one reconciles the loss of these almost irreplaceable trees with the bright economic future that our nation and our continent has?

DR. DURWARD ALLEN [Purdue University]: I would like to put another question to Mr. Fisher. I would like to say, however, I have had the privilege of hearing two economists in a row talk about ecology and, if I have gained nothing else from this conference, that was worth coming for.

I believe Mr. Fisher referred to the need of keeping ahead of our needs resource-wise and development-wise in this country. In other words, keeping ahead of what the population is going to require for whatever standard of living it will settle for, and I would like to ask this question.

Now in keeping ahead of need, I believe that maybe as population ecologists we should hold in mind also the proposition that a population doesn't expand in thin air. It grows with reference to a resource base, and the more we expand this resource base, the more population we are ultimately going to have if we don't control it, and I don't see the control developing very rapidly, so we are carrying out some of our developments of so-called underdeveloped areas or vacant areas on our map at high public cost, and I wonder if we have a long-term incentive to spend a lot of money getting a piece of barren desert onto the tax rolls or draining the water off a duck marsh to grow more wheat because ultimately maybe we will need the wheat.

I wonder if we have a real incentive for that kind of development when we consider that this increased area, this broader base is going to grow more people as well as other things.

MR. FISHER: I think in many of our land development programs we are not spending our money and our effort wisely. It is my belief that in many parts of the West the same thing can be said of the effort we put into the development of water. It's fine and all right, but we then proceed to use the land and the water frequently for things that aren't very much needed, and this is bad economics. It's bad management. For example, in many parts of the West, additional supplies of water that may be developed would yield far greater returns in industry and in general domestic use than in agriculture.

Of this there is no doubt in my mind, and I can cite very good, solid studies to back it up. I wouldn't have you think that because there seems to be a fairly rosy hue to my picture of the future that I think there isn't a lot of work to do, and the good picture won't come true, I am sure of this, if we all just settle back and do nothing and let land go into one use when it should be either not used at all or used for something else.

But I would like to say just a word on the basis for what you would regard as my optimism about the future. It isn't something that I take out of a crystal ball. I base it entirely upon historical studies of trends in the price and cost over many decades of getting essential raw materials for this economy, and as you look back over that and look back carefully in the most careful statistical way possible, you simply do not find a picture of greatly increasing costs, and what other better measure is there for increasing scarcity than this I would like to know?

The picture simply isn't like that even for a metal like copper, which many people would say must be becoming more scarce in an economic sense because we have to go deeper for it. Well, we now use much lower grade ores, less than 1 per cent of copper content compared to 10 or more per cent some years ago. To be sure, we do that, but technique has kept pace with that. The result of it all is that having the world in view we get copper to our users in this country at no increase in real cost.

Now as compared to a long, long time ago, and this is the story in many, many, many of the raw materials, not all of them, but many of them, and I simply wanted to add that this is the basis I have for drawing a reasonably optimistic picture for meeting our demands for raw materials and resources for several more decades.

DR. F. FRAZIER DARLING [Conservation Foundation]: I just wonder sometimes in an assessment of resources that we have for the future who makes these assessments for the future? As ecologists we look at certain things that are being assessed and as ecologists can we in any way agree with the assessments that are being made of them? I don't think so.

Africa is being looked upon as a great world-giver of the future. My own opinion over several years visiting a great many parts of Africa is that it is an extremely brittle and hollow promise for the future. The same thing in Alaska. I heard of the Kuskokwim Yukon Delta being put forward as the granary of the future, and what sort of craziness is this? And yet, I mean, the people who will talk of the wheat-producing possibilities in Alaska, I hear it on all hands, and it just isn't there.

There is much more, too, to a granary for the future than how much technique, how much improved plant breeding you can do to produce these things. You can farm good land a good deal better for a much larger increase in food resources than you can get out of clawing up a new country like Alaska.

In Africa you are dealing there with a tremendously old country, not a new country that has just come out of the earth, but an old one that is senile. The soil is senile. Thousands and thousands of square miles of Central Africa plateau which are now being looked upon as possibly providing food for the future. It scarcely feeds the very low population of people that are there right now.

There was an FAO Mission who in a moment of honesty of expression said that they could not see any better usage of that ground, any better system of conservation farming than the shifting cultivation of this very small population which lives there at the present time. Yet, this is one of the great places of the future. Cattle in Africa? There is a very big report extant in this country now for American intervention into Africa in which it is explained that the tropics is a highly suitable place for animal production. That I would argue with anyway, but let it pass.

Then the next thing is Africa is a large exception to this rule. Large areas of Africa are suitable to animal production. Why? We have only to look at the large number of hungry species that have moved, to see how good this place is for animal production. This completely ignores the fact that where you have twenty or thirty wild species in constant movement utilizing a habitat or any series of habitats in Africa, you find between twenty and thirty species of ungulates using that habitat, but here the idea is to decrease the spectrum down to two or three species. Reduce it to a tenth, and this is going to be the great resource for protein in Africa. Now ecologically it's nonsense.

I am not here to disagree with Dr. Fisher. I am only asking that assessment of these great resources for the future should be considered ecologically and not by some crack-brained, halfbaked type of agriculturalist who thinks that God speeds the plow and this is the answer to the whole problem. It is not. At least these assets are being wrongly assessed. Thank you.

VICE CHAIRMAN ROSS: Thank you very much, Dr. Darling. We are, indeed, grateful to you for speaking to us and for being with us at this meeting. It has been a strong influence on all of us.

PART II
TECHNICAL SESSIONS

TECHNICAL SESSIONS

Monday Afternoon—March 7

Chairman: JAMES S. LINDZEY
Chief Upland Ecologist, Patuxent Wildlife Research Center, U. S. Fish and Wildlife Service, Laurel, Maryland

Moderator: MAURICE GILTZ
Assistant Professor of Zoology, Agricultural Experiment Station, Ohio State University, Wooster, Ohio

---

DEPREDATIONS CONTROL SYMPOSIUM

REMARKS OF THE CHAIRMAN

JAMES S. LINDZEY

This is Technical Session No. 1, Depredations Control Symposium. We think we have a rather interesting program this afternoon. We have brought together as nearly as possible everyone we could find who had an interest in the bird depredation problem, and I think as these papers progress, you will appreciate as we do some of the refinements and interesting points that will form a basis for discussion. Because of the way the papers are organized, there may be questions that you have as we go along that will be answered later, and so we are going to ask that you hold your questions until all of the speakers have had a chance to give their papers, and then we will have a discussion period at the end.

Perhaps one of the most interesting aspects of this session is the fact that we are not only bringing these folks together from many walks of life to discuss a problem, but we are exemplifying a problem, the solution of which may mean a lot to us, not only in our immediate problem with the blackbirds, but in our problems with other wildlife species. This is one of the reasons for our major interest in this particular problem.

THE NATURE AND EXTENT OF BIRD DEPREDATIONS ON CROPS

MAURICE L. GILTZ
Ohio Agricultural Experiment Station, Wooster, and Ohio State University, Columbus

The purpose of this paper is to give an insight into the nature and extent of the problem of agricultural crop depredation by birds.

People everywhere have always looked upon birds as beneficial animals which destroy many harmful insects and weed seeds, provide much pleasure to those who observe their presence and their habits, and intrigue the biologist with their migrations. True as this is there are some species which at some time during their life cycle feed upon man's best agricultural crops causing losses amounting to millions of dollars. This presents the problem of preventing these depredations by outwitting, deterring or destroying the birds.

The solution to the control of birds in agricultural crops is one of the most challenging problems in modern times because it deals with the phenomena of bird migration in addition to the usual ecological complexities. In general, the damage is done to crops when migrating birds accumulate in large numbers temporarily in marsh or tree roosts at night, and forage the adjacent crop land each day. Since most of the damage to crops occurs in fields relatively near the roosts, or on flyways to and from the roost, a knowledge of the mechanisms of migration, roost formation and dispersions from the roost is essential as an approach to the problem. However, the mechanisms by which the birds operate their migrations and homing feats remains a mystery, and to date we have no clue as to how to prevent the accumulations of millions of hungry birds from coinciding with the soft-grain stage in many of our cereal crops.

The ecological complexities in the problem of preventing the destruction of crops are equally intriguing because the damage is caused directly and indirectly by a variety of bird species on the same and different crops. In order to understand the depredations of crops by birds we must consider the life history and habits of each bird species, each crop in which the damage occurs, the geographic location of the damage and the season in which the damage occurs. We must also consider the effect of our treatments on the crops and associated species of animals.

The following is a partial list of the species of birds involved in the problem, the crops damaged, and the States in which the damage occurs: redwings, rusty blackbirds, starlings, grackles and cowbirds damage corn and sorghum in parts of Colorado, Connecticut, Delaware, Florida, Georgia, Illinois, Louisiana, Massachusetts, Michigan, Nebraska, New York, North Dakota, Ohio, Texas, and Virgina; blackbirds damage rice in Arkansas, Texas, California, and Louisiana; blackbirds and English sparrows damage sorghum in Texas, Nebraska, Arkansas, Florida, Georgia, and Virginia; larks damage tomatoes and melons and white-crowned sparrows damage lettuce in California; mockingbirds and robins damage blueberries in Mississippi; robins and starlings damage cherries and blueberries in Ohio; orioles damage strawberries and blueberries in Connecticut; ring-necked pheasants pull sprouting grain wherever they are present at planting time; crows and blackbirds pull sprouting grain in Ohio; juncoes and various warblers damage grapes in Ohio; various species destroy planted pine seeds in the South; ducks damage grain in North Dakota and waterfowl damage agricultural crops along the Pacific Flyway.

This list was compiled from answers given by State Experiment Station Directors in response to a survey made by the Bureau of Sport Fisheries and Wildlife. These answers indicate that at least 20 species of birds are important in that they do damage to 10 different agricultural crops in at least 20 different States. Undoubtedly many other bird species and many other damaged crops are not listed here because the damage is considered minor.

One of the peculiarities of this problem is that millions of dollars of damage is done to a small percentage of the growers; that is, relatively few growers suffer 100% of the depredations done by the birds and most of the growers do not know that a problem exists. Unless the farmers bring it to the attention of the Experiment Stations it often goes officially unnoticed. Another peculiarity is that damage is not always suffered each year by the same farmer and many do not consider it serious until it occurs annually. However, those farmers with fields of corn, sorghum or rice near a roost or flyway must guard their fields each day of each year at the time that their crop is susceptible to damage or suffer major losses.

One of the factors in the complexity of this problem is the generalized nature of the birds which enables them to live in a variety of situations. They have become adapted to our agricultural environments, man-made marshes, and to our cities. In spite of man's best efforts to thwart the well-being of those which destroy crops and those which create a nuisance, they continue to increase in numbers. This is especially true of the blackbirds which are the greatest offenders in the crop depredation problem. The redwing, in particular, is structurally an upland species which nests, roosts and feeds in marshes as well as on the upland farms. Their nests are built in a variety of ecological niches throughout North America. They feed on a great variety of both animal and plant material and migrate from their nesting sites to roost in a variety of marshes, shrubs and trees.

Investigations have shown that although the redwings eat insects almost entirely during this nesting season, they are primarily soft seed eaters throughout the remainder of the year. Agricultural practices encouarage these feeding habits in that there is an abundance of corn, wheat, oats and rice available to birds before, during, and after harvest and in the case of rice and oats it is often available following planting. In recent years their assault on soft corn, sorghum and rice makes growing these crops near a blackbird roost an economic hazard. They also eat all other available soft seeds, including undesirable weed seeds and maturing seeds of crops sometimes planted by marsh managers for waterfowl food.

The fact that I have mentioned some of the interrelations of the blackbirds in corn and rice does not mean that additional crops damaged by other species of birds are not equally important to the growers suffering the damage. It is believed that much of the research information discovered to be applicable in one problem will be of value in the control of other species on various crops and of value in nuisance problems. However, identical control methods are not likely to work the same for all species on all crops and specific control methods may have to be developed.

Since the range of the birds extends throughout the continent and the species of birds involved in the damage includes species as different as waterfowl, blackbirds and warblers, many individuals and agencies are interested directly or indirectly in methods of controlling the depredating species in a manner that would not conflict with another individual's interests.

From the crop depredation viewpoint the farmer with fields near the roosts must save his crops from destruction by the birds. He must depend upon the biologists for clues to methods of control. The biologist desires to consider the effects that control measures used on depredating species would have on other species associated with them and prevent promiscuous expenditures of materials, energies and life. The blackbirds feed, nest and roost in the same habitats as waterfowl and other game birds and measures taken to reduce the welfare of the blackbirds would also reduce the welfare of waterfowl and other wildlife.

Because of the interrelations between agricultural crops depredating bird species, ornithological interests, wildlife interests, and public health interests, the problem is seen to be one with no local, State or National boundaries. It must receive a coordinated attack by all agricultural, ornithological, biological and governmental agencies.

SUMMARY

Depredations of crops by birds occurs in general when migrating or wintering accumulations of birds coincide with a crop in a stage of maturity that is susceptible to birds using the crop for food. Ten agricultural crops are badly damaged by at least 20 species of birds in parts of at least 20 States. The value of these crops destroyed by birds amounts to several million dollars for corn, rice, and sorghum. Losses to individual farmers often amount to over a thousand dollars.

MANAGEMENT TO AVOID BIRD DEPREDATIONS

ROBERT T. MITCHELL
Patuxent Wildlife Research Center, Laurel, Maryland

Agricultural bird-damage problems vary greatly according to the bird species involved, the type of crop, the season, geographical location, and other factors. Possible approaches to damage control include 1) excluding birds from the area, 2) making the crop unavailable to the birds present, 3) making the crop unattractive to the birds present, and 4) reducing the number of birds. No one of these approaches is best adapted to all damage situations, and effective depredations control depends upon proper selection of techniques available. Descriptions of some of these techniques, and information on their capacities and limitations for a single crop are given in Wildlife Leaflet 385, "Protecting Corn from Blackbirds." The development of new techniques, and the refinement of existing ones are urgently needed. Dr. Lindzey will discuss research progress and needs later in this Session.

Birds can be excluded from areas by physical barriers or by frightening devices. Physical exclusion, as by paper netting, is suitable for small areas, such as home gardens and fruit crops, but is not feasible for most commercial operations. Scare devices are extremely effective under certain conditions. In general, their effectiveness is directly proportional to the availabliity of alternative sources of food and to proper application of the method, and inversely proportional to the size of the area to be protected.

Scare devices that produce explosions automatically, and thus keep labor costs low, generally are preferable to those such as firearms that require manual operation. Nevertheless, .22-calibre rifle shooting is economical on an acreage basis because of the effective range of protection it affords, for one man can protect 100 acres of cropland in a solid block. The rifle must be used with considerable caution, however, for shooting is hazardous to neighboring property, livestock, and humans. Carbide exploders sometimes provide adequate protection, especially in small fields. Models of carbide exploders, in which the gas comes from a compressed gas tank and is ignited by a spark, are generally more satisfactory than those which have a pilot flame and generate gas by dripping water on carbide powder.

Rope firecrackers, described in detail in Wildlife Leaflet 365, are more effective automatic scare devices than are carbide exploders, but the hazard of fire and legal restrictions limit their use.

Cultural practices that make crops less available to birds offer considerable promise for reducing damage to certain crops in certain areas. For example, planting seed deeply often reduces losses of sprouted seed; delaying planting until after some birds have migrated may result in considerable savings, as it has with rice culture in Arkansas; planting to assure that the crop matures when natural foods are abundant may reduce damage or enhance the effectiveness of scare devices; and using varieties of grain that are exposed to bird attack for a shorter period of time, such as wheat varieties that need not be swathed, may reduce damage markedly. Sometimes modified cultural practices alone may protect crops sufficiently to eliminate the need for other protective measures.

Crops sometimes can be made unattractive to birds by chemical repellents, but often there are difficulties and problems. A repellent must be inexpensive and easy to apply and must not be phytotoxic. When the crop serves as food, the repellent must not be toxic or distasteful, and it must not discolor the product. Chemicals have been found that will protect planted pine seed, but none has been proven wholly satisfactory for protecting corn seed, ears of corn, or exposed grain such as sorghum or rice. Field research has shown that certain varieties of corn and sorghum are less attractive to birds than others, but relatively few tests have been made, and efforts to develop damage-resistant varieties have scarcely begun.

Directly reducing the number of birds may bring temporary relief from damage, but it also removes any benefits that may come from the birds feeding on insect pests. It, therefore, is the least desirable method of damage control. When bird control is considered necessary, it can be accomplished in several ways. The principal methods are shooting, poisoning, trapping, and bombing, gassing, or spraying of roosts. Shooting is expensive, and is ineffective except against small local populations. Large numbers of blackbirds can be poisoned with treated bait, but this method usually is unrewarding during the growing season when ample plant food is available. Furthermore, poisoning is not selective for particular kinds of birds, and use of poisons is strictly regulated by Federal and State laws. Trapping is selective, but most methods are not effective during the growing season. Further development of a floodlight trap now used for obtaining blackbirds and starlings from winter roosts for banding and other research purposes may permit its use in operational control during the summer months.

Bombing, gassing, or spraying winter roosts may sometimes be developed as an effective method for blackbird control. Hundreds of thousands, or even millions, of the birds congregate nightly at a single roost. It is not easy to plan a satisfactory method for poisoning, however, because the roosts are established in so many different kinds of habitats, each of which may need a special technique. Some of the roosts are in remote marshland or forest. They may be in cutgrass, cane, reed, or brush, in deciduous or coniferous trees. Other roosts are close to human dwellings, some even in cities. An important problem in poisoning roosts is the hazard to people, livestock, and other animals, for no chemical agent known at present is specifically toxic to birds.

SUMMARY

Bird-damage to crops can be reduced by different methods. Birds can be excluded from small areas by paper netting. They can be frightened away by rifle shooting, carbide exploders, or rope firecrackers. They can be discouraged by cultural practices, such as planting seed deeply, or adjusting the planting and harvest times, or by using varieties of plants that are less susceptible to damage. They sometimes can be repelled by chemicals. Limited control can sometimes be obtained by shooting, poisoning with treated baits, or trapping. Some day, they may be controlled by bombing, gassing, or spraying the roosts, but these methods involve many problems and are still in the experimental stage.

LITERATURE CITED

Mitchell, Robert T. and John T. Linehan
1957. Protecting corn from blackbirds. U. S. D. I. Wildlife Leaflet 385.

Neff, Johnson A. and Robert T. Mitchell
1956. The rope firecracker. U. S. D. I. Wildlife Leaflet 365.

MANAGEMENT TO AVOID WATERFOWL DEPREDATIONS

CLINTON H. LOSTETTER

Bureau of Sport Fisheries and Wildlife, U.S. Fish and Wildlife Service, Portland, Oregon

During the past 30 years there has been an extensive land-use change whereby much natural waterfowl lands have been converted into profitable croplands during the process of agricultural expansion. Waterfowl, for survival, have been forced to go elsewhere—onto the greatly reduced natural habitat areas or onto the newly-developed croplands instead. It has been inevitable that we should have this competitive situation before us, and it will probably continue and possibly increase as waterfowl's natural habitat diminishes.

In recent years we have been more aware of the waterfowl damage problem because the competition for land and water has been increasing. Land, with its food and water, is a basic requirement for waterfowl survival. The economics of agricultural production have brought the depredation problem into sharp focus when waterfowl descend upon agricultural crops for food. Thus, we must face the problem of waterfowl crop damage control management in order to minimize crop losses. Generally, we have four main management methods to guide us in dealing with this problem, and they are:

1. To develop national and state waterfowl management areas with food and water to supplement the loss of natural habitat.

2. To devise and use certain mechanical devices and techniques to scare waterfowl from potential or present damage areas.

3. To use regulatory measures when necessary to maintain a balance of bird population with available habitat.

4. To educate the farmer so that he can help himself with his bird damage problem.

The ultimate success of any crop protection program is usually a combination of two or more of the above methods.

DEVELOPMENT OF WATERFOWL MANAGEMENT AREAS

Probably the most important control measure in waterfowl depredations management is the practical development of designated feeding, watering, and resting areas strategically located. These managed areas, to a great extent, supplement the loss of natural waterfowl habitat taken during the advance of agriculture. The furnishing of food and water on these areas at the proper time does have a marked effect on reducing crop damages (Horn, 1949).

The habitat development program for depredation control began as an experiment in the western part of this country 16 years ago, and today it has proven to be very successful. This type of crop development has set a pattern for waterfowl management by controlling the environmental factors of food and water. A duck has to eat somewhere, and his feeding on these designated management areas has shown that duck damages to commercial crops can be minimized by such planned operations (Lostetter, 1956).

A good example of crop loss reduction can be shown by the cost operation figures of a large grain grower in the Tule Lake-Klamath area of northern California. This farmer advised that in 1947 his crop losses and expenses to combat duck depredation to his valuable barley amounted to about $80,000. After several years of development of the managed feeding and resting areas at Tule Lake-Lower Klamath National Wildlife Refuges his annual losses and bird-control work were reduced about 95 percent. This certainly points to a beneficial pattern of management for avoiding waterfowl depredations.

The farming for waterfowl is not new, and these agricultural techniques have been in common use on Federal and State management areas in the Pacific Flyway for a dozen or more years (Scheffer, 1959). The strategic location of these areas has had a definite bearing on holding waterfowl, mainly ducks, from heavily foraging onto adjacent croplands during the critical fall depredation period. In California, for example, in spite of the large annual acreages of barley and rice, duck depredation crop losses since 1952 have been reduced.

On many Federal areas, plantings of certain cereal crops such as rice or barley, or millet, have given positive results in reducing threatened and actual crop damages. On many of these areas waterfowl have shown a preference for these crops to the natural aquatic waterfowl foods present. The timing of the availability of these crops for the birds is quite important in this phase of a control program. For example, the planting of millet crops, to mature early in the fall, aids in feeding early duck migrants; while rice crops that mature during September and October help to fill the need during that period. Consideration of planting dates, growing period, and water controls is all important in bringing the crops to maturity for maximum use (Lostetter, 1956).

In areas where large acreages of mature commercial barley are threatened by waterfowl attacks, properly planted management areas of barley crops induce the birds to feed on such areas. It has been shown that when these feed areas are large enough, depredations can be avoided with a minimum of bird herding and harassment. Green fall-sown barley affords goose food during the winter period. Standing and mature barley is readily taken by waterfowl, mainly ducks, in a dry or flooded condition. On certain management areas proso millet, *Panicum milisceum,* and sudan grass, *Holcus sudanenses,* have shown value as depredation-control crops.

USE OF MECHANICAL FRIGHTENING DEVICES AND TECHNIQUES

The mechanical devices used in waterfowl crop damage control are as varied as one's imagination, many of which are an effective deterrent under certain conditions. These devices are meant to scare, frighten, or deter birds from the croplands, and seldom harm the birds.

Proper use of any of these bird-frightening devices demonstrates that early preventive measures are cheaper and more effective than the laborious task of getting waterfowl out of a crop once they have established their feeding habit. It is common sense to get at the potential damage problem early *before* any damages take place; this point is paramount to an individual if his efforts are to be successful. Concentrated control efforts before depredations occur can prevent serious crop losses.

Some of the following frightening devices are in common use by ranchers, and many are standard equipment in their crop-protection operations. These devices include the various modifications of the scarecrow, spirillum whirlers, "scotchlight" reflectors, as well as the shotgun, rifle, pyrotechnic flares, exploding aerial flash and sound bombs, sky rockets, oil-burning road flares, automatic exploders, revolving light beacons, and exploding shotgun shells. Experimentally, sound-producing machines, fog-making machines, and battery-operated road construction flashing signals have been tried with varying success.

The method used by the farmer in frightening the birds depends on the type of crop and its stage of growth, the terrain, the period of day, and common sense. In other words, the revolving beacon light would be effective only at night, and inflammable devices generally must be cautiously used over a field of ripening grain. Hochbaum (1954) stated in his experimental depredation control work in Manitoba that the combined use of scarecrow and shotgun herding was quite effective in crop damage prevention. This latter method of operation has been successfully used for many years in the barley fields of the Klamath-Tule Lake Basin.

The revolving beacon light is often a satisfactory device to use in fields where the land is generally level and where vegetation is not too high. The sweeping rotation of the light beam over the crops creates an eerie and fantastic movement of light. This light appears rather rhythmical and undulates as it passes over and through the crop during its rotating cycle. It has been observed on many occasions that the effect of these rotating lights is frightening to the birds and a definite aid in protecting crops of alfalfa, pastureland, rice, and barley. The light's size, its proper placement in the field, and the size of the field are all important to its efficiency. The revolving light has wide use, especially in the Imperial Valley of California for alfalfa protection; in the Central Valley of California for rice, pasture, and green grain crops, as well as on various pasturelands and grains in Idaho, Washington, Oregon, and Nevada. Stephen (1959) indicated in his Canadian depredation experiment that the revolving searchlight prevented ducks from occupying an area up to one-half mile radius from the source of a 1,000-watt light.

The automatic acetylene exploder has become a popular device in parts of the West during the past two years. It is reasonably effective in keeping waterfowl from grain and pasture fields, as demonstrated in parts of California and Washington. Stephen (1959) indicated in his depredation control experiments in Manitoba and Saskatchewan during the fall of 1959 that the acetylene exploder was considered to be a most practical device and offered good crop protection. It was reported that after a convincing demonstration of the automatic acetylene exploder, several farmers in the Meadow Lake area in Saskatchewan purchased these devices.

In the winter of 1954, I carried out an experiment in crop-damage control in the Imperial Valley of California, using blinking road-flasher lights identical to the road warning signals used by construction companies. A 160-acre alfalfa field was selected which had sustained very recent crop damage from widgeon. This alfalfa was damaged at the succulent stage of development (3 to 7 inches high), which is preferred by these ducks. Some 24 of these lights were set on the borders, or longitudinal irrigation levees, in the field at a point slightly above the top of the crop. They were dispersed over the field so that about 100 acres in the center of the area were covered. After 33 days of continual operation the lights were removed. The alfalfa crop was then 14 to 15 inches high, and no evidence of further widgeon damage was experienced.

The use of the exploding shotgun shell fired from a 12-gauge shotgun offers some positive means of frightening waterfowl; but an operator must be present to fire the gun, thus adding to the labor costs. However, the use of this device will offer reasonable protection for about one-half to one section of land, depending upon the location of the operator. The cost of these cartridges is about equal to the price of most low-base shotgun shells. Currently, these exploding shells are produced only abroad, but a U. S. manufacture is expected to be in production by this spring.

REGULATIONS FOR DEPREDATIONS CONTROL

The duck depredation problem has been taken into consideration during the process of preparing the annual migratory bird-hunting regulations. Some of these regulatory measures, of significance to agriculture, have included the opening and closing dates of the hunting seasons, bag limits, and the issuance of herding and killing permits (U. S. Fish and Wildlife Service, 1954).

For example, in setting the opening of the waterfowl season several years ago in the Pacific Flyway, an attempt was made to consider the increase in amount of rice acreage in the Central Valley and alfalfa crops in Imperial Valley, and their relation to potential duck damages and crop harvest period. To the basic duck bag limit in the Pacific Flyway, from 1952 to 1958, was added the so-called "bonus" on depredation ducks (U. S. Fish and Wildlife Service, 1952-58). These depredating ducks, pintail and widgeon, were allowed in the bag in order to help alleviate serious damages to rice, barley, and alfalfa crops. It was reasoned that these ducks were a part of an unharvested segment of the fall migration, and could be taken without serious harm to the overall population. Conversely, in periods of reduced waterfowl production it is only good management to eliminate the so-called "bonus-bird limits" from the regulations.

Another Federal regulation and method of bird-damage control is the use of the depredation orders as issued by the Director of the Bureau of Sport Fisheries and Wildlife. These orders are promulgated for the relief of agricultural, horticultural, and fish culture interests when migratory game birds in a particular area are in such numbers as to cause or threaten to cause serious damages (Fed. Reg., 1958). These orders are placed into effect only when other damage-control methods have failed and are not an extension of the hunting season. The terms of such orders specify the particular area, type of shotgun, species of birds, use of birds taken, and period that the order is in effect. Examples of these depredation-control measures have been for the killing of widgeon in Imperial Valley of California in 1944 and 1956. During the past three years a depredation order has also been issued for killing American mergansers on designated streams, lakes, etc., in western Washington to prevent serious depredations to trout populations (Fed. Reg., 1960).

Horn (1949) stated that special depredation orders alone afford but little hope in relieving the crop damage situation unless the idea of taking these depredating species is to reduce drastically the local population. In this respect the widgeon depredation orders issued for Imperial Valley were an attempt by legal means to assist farmers in the abatement of alfalfa damage when these crops were seriously threatened. The number of widgeon taken under this authority was insignificant and did not drastically reduce the population. The results of the orders are twofold: (1) A favorable psychological reaction from the farmer, and (2) the actual harassment and reduction of the offending species.

Some of the States' game codes have specific sections relating to waterfowl depredation controls. California's administrative code gives the Fish and Game Department authority to approve all depredation orders issued by the Federal Government authorizing the killing of migratory game birds to alleviate crop depredations. Also, this department approves the issuance of crop depredation permits by the Federal Government to kill or herd migratory game birds when conditions so justify (California Fish and Game, 1958).

EDUCATION OF THE FARMER

Any of the various frightening devices are of little value without the personal understanding of the farmer. If he has the correct technique and exerts the effort, he can, with the proper device, assist himself to substantially reduce his crop losses. An important depredation management tool has been and will continue to be education of the farmer to the tested and proven techniques of herding. Gascoyne (1949) relates that a cooperative approach in teaching the farmers in the use of frightening devices is more an educational problem than one of law enforcement. This phase of the depredation program does move slowly, but the combined efforts of "on-the-ground" contacts by Federal and State conservation personnel have shown remarkable results.

In some areas in the western United States, various Federal and State conservation personnel give demonstrations of the latest bird-frightening devices and techniques to various farm groups. Sometimes demonstrator revolving light beacons are set up on a ranch to show the practicality of this device for protecting crops from waterfowl damages. In Imperial Valley of California as a result of this demonstrational work several years ago, local ranchers have purchased and maintain some 70 revolving light units to frighten ducks.

Experience has shown that a tactful approach to a rancher pays off in his desire to assist himself when he has been properly instructed. On the other hand, an unfriendly or negative approach to a rancher by a conservation officer usually meets with rebuff and antagonism. If, however, a flagrant infraction of the bird protection regulations occurs in either the State or Federal realm, the incident should be met with firmness and fair treatment.

A good example of education and cooperation in depredation control management is the coordinated airplane and ground herding over rice crops in the San Joaquin Valley of California. Here, two airplanes cover some 30,000 acres of riceland for a period of 60 days during the crop damage period. The efficiency of their activities over the years has improved with suggestions made by certain State and Federal conservation officers. Such airplane herding is done at dawn and just before sunset, when the flights of the ducks in and over the fields can be controlled by plane. The effectiveness of these herding operations is related to the location of the commercial crops and waterfowl management areas' crops (Biehn, 1951).

SUMMARY

To avoid waterfowl depredations probably the most important single measure of control is the establishment of managed feeding areas. These areas supplement the loss of some natural habitat and afford a place to where the birds may be herded and fed, and are less likely to damage commercial crops in the community.

There are a variety of mechanical devices used in herding migratory waterfowl, each of which is an efficient deterrent under certain conditions. Automatic exploders and revolving duck lights are very good unattended devices for keeping birds out of valuable crops. The exploding shotgun shell does offer some positive means for frightening waterfowl and abating crop damages.

The use of hunting regulations has, at times, been of assistance in cropping the unharvested surplus of certain duck species during acute depredation periods. Another form of Federal regulation is the use of a depredation order for the killing of migratory game birds when agricultural, horticultural, or fish culture interests are threatened by serious damages. These orders in the past have brought about certain favorable results.

To avoid waterfowl crop damages the farmer must have the correct "know-how" in order to help himself. It is important that he be informed on the latest bird-frightening devices and techniques so that he can be prepared to act. Demonstration to the farmer of bird-frightening techniques and equipment by conservation officers produces good relationship and aids depredation control.

LITERATURE CITED

Biehn, Earl R.
1951. Crop damage by wildlife in California. California Department of Fish and Game —Bulletin No. 5, Part II, pp. 44-70, Sacramento, California.

California Department of Fish and Game
1958. Orders, Rules and Regulations for 1958, Title 14, California Administrative Code. Section 310, Crop Damage. Sacramento, California.

Federal Register
1958. Authority to issue depredation orders—§6.65 CFR, Congress of the United States. Washington, D. C., December 17, 1958, p. 9712.
1960. Depredation order for merganser in State of Washington. §6.65 CFR, Congress of the United States, Washington, D. C., January 14, 1960, p. 284.
Gascoyne, D. R.
1949. Law enforcement problems in waterfowl management. Trans. 14th North American Wildlife Conference, pp. 95-99.
Hochbaum, H. and Dillon, P. T., et al.
1954. An experiment in the control of waterfowl depredations. Trans. 19th North American Wildlife Conference, pp. 176-185.
Horn, E. E.
1949. Waterfowl damage to agricultural crops and its control. Trans. 14th North American Wildlife Conference.
Lostetter, Clinton H.
1954. An experiment in waterfowl depredations control, Imperial Valley, Calif. Unpublished report pp. 1-6.
1956. Environmental control in waterfowl. Trans. 21st North American Wildlife Conference, pp. 199-209.
Scheffer, Paul M.
1959. Farming for waterfowl in the Pacific Flyway. Trans. 24th North American Wildlife Conference, pp. 238-243.
Stephen, W. J. D.
1959. Cooperative waterfowl depredation investigation. Canadian Wildlife Service, Saskatoon, Saskatchewan, Canada, November 9, 1959, pp. 1-12.
U. S. Fish and Wildlife Service
1952-1958. Federal regulations relating to migratory birds. Washington, D. C.

RICE CULTURE IN CHICOT COUNTY AS PERTAINING TO BLACKBIRDS

CLIFTON M. POWELL
The Crop Savers Association, Eudora, Arkansas

Chicot County is located in the southeastern corner of the State of Arkansas and lies adjacent to the Mississippi River, the river forming the eastern boundary line.

Our county grows a total of 8500 acres of rice and a large acreage is planted to other small grain crops such as wheat. During 1957 a group of our farmers were organized in order to explore the possibilities of reducing blackbird damage to our crops, knowing it would be necessary to reduce this damage if we were to survive. We estimated there were 15 large roosting areas along the Mississippi River within the county.

We elected officers and named our group the Crop Savers Association and collected approximately $2500 to start this program.

After investigation we found a similar group in our state had used dynamite bombs. We obtained the necessary equipment to carry out this operation and were successful in getting several million blackbirds, but there are many reasons why this method is not satisfactory, the main one being the cost and danger to personnel and the inaccessible location of the roosts.

In assessing our annual damage we solicited the assistance of our farm bureau, which mailed out mimeographed forms to each grower with a request that they estimate the damage to their crops conservatively.

There are two seasons of the year that the damage occurs—planting time and after the rice has headed. The planting season in our area begins about April 1 and lasts through May 20. It is necessary to plant at least one bushel per acre more than usual to take care of what the birds eat. They also destroy many seedlings after they have emerged. This calls for an additional expense through use of strychnine and chops applied with a plane to our fields and firearms used to attempt to keep them run out.

Blackbirds in our area start eating rice in the milk stage and continue until it is all harvested. Most of the farmers use carbide, automatic carbide scareguns, .30-06 rifles, .22 rifles, shotguns and airplanes to scare the birds out of the fields. The average estimate shows they consume or destroy 10 per cent of our crops. We have extreme cases where entire fields have been destroyed and the rice not harvested at all.

In summarizing we find that the damage is as follows:

	Cost per Acre
Seed destroyed by planting	$ 4.00
Control expense at planting	1.00
Control effort at harvest	8.00
Eaten or destroyed at harvest based on 10 per cent county average of 73 bushels, 7.3 bushels per acre at $2.00 one bushel	14.60
For total cost and loss	$27.60

By multiplying 8500 acres by $27.60 we find it amounts to $234,600 in rice damage alone in Chicot County.

It is felt this is a very conservative estimate. Because of the heavy damage we continue searching for means to alleviate the situation. In addition to methods described, we have tried various chemicals mixed with water and Diesel fuel applied with planes on the roosts at dusk while the birds were roosting. Malathion was found to be ineffective. Ethyl parathion mixed with Diesel fuel will kill, but not in sufficient numbers to be acceptable.

Tetraethyl pyrophosphate, better known as "Tepp," was found to be very effective. It has been estimated by two members of the United States Fish and Wildlife and two state game wardens who were advisors of our dynamite and Tepp operations that, with five gallons of Tepp used in the experiment, as many birds were destroyed as with 500 dynamite bombs, and the expense was less than one-twentieth.

It is the opinion of this organization that control measures must be effected as soon as possible with this or some other immediate action.

THE STATE GAME AND FISH DEPARTMENT AND BIRD DEPREDATIONS

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

In discussing a Game and Fish Department's relationships to bird depredations, I would like to note, first, that such a Department is primarily concerned with game species. Since the principle form of bird depredation in Arkansas has been that of blackbirds on rice and small grains, and has not been due to depredations by a game species, this problem has been, fundamentally, an agricultural problem.

On the other hand, both the Game and Fish Departments, and the U. S. Fish and Wildlife Service are legally authorized to protect passerine birds, which include those blackbirds and other forms which feed on rice and grains. Beyond this, they are concerned with the problem of land use, as it affects all wildlife and the repercussions of control measures on other species and on wildlife habitat and ecological relationships. They must also, as a conservation agency, be concerned with the esthetic values these birds have for many people, and the beneficial effects they may have in keeping noxious insects under control.

Since a Game and Fish Department is, primarily, a service agency, which must consider these varied interests, I believe their main function should be advisory to, in so far as possible, furnish reliable data on which a program satisfactory to all interests may be based.

From the information presented at this meeting, it is apparent that bird depredations are, in some instances, a serious problem. Neff and Meanley (1957) surveyed this problem rather thoroughly in a bulletin titled "Blackbirds and the Arkansas Rice Crop." In this report, they pointed out that the total loss of rice to these birds was small, seldom exceeding one per cent of total production. They also pointed out that blackbirds compensated for the damage they caused, to some extent, by eating large amounts of weed and grass seeds, and by consuming weevils, army worms and other noxious insects, particularly during the nesting season when they were feeding young. They did fully recognize the losses individual planters often sustained, and recommended measures which could be taken both to control bird numbers and mitigate losses. They recommended the use of frightening devices, repellents, trapping, shooting, and the use of poisoned grains among other methods. Because these birds often descended in numbers on individual fields, they expressed the opinion that vigilance to protect fields from depredations during the period just prior to harvest was one of the most suitable ways to prevent losses of rice and other grains.

They also pointed out that these birds migrated to the south shortly after harvest, and that controls applied in the late winter had relatively little effect in controlling those birds which were previously responsible for rice losses.

I do believe that any action the farmer takes to protect his means of livelihood is justified, and his concern, until control measures which begin to have repercussions damaging to other interests must be considered. Such controls as shooting, frightening, use of repellents, etc., when they are carried out by individuals or groups of land owners, have few effects beyond the immediate protection of the land owners interests. When, however, toxic poisons or other controls which may affect other wildlife, fish, water supplies, or human health are applied, those other interests become involved in the economics and side effects of control measures. Such poisons as T.E.P.P., parathion, and D.D.T. are highly toxic to warm-blooded animals and to man. They may destroy other wildlife, and fish, contaminate crops and thereby affect man's interest in and use of these other resources. It is at this point that Game and Fish Departments have an acute interest in the type and extent of blackbird or other bird control. The long-term, residual effects of these poisons is also of major concern.

As a public agency, a Game and Fish Commission should, I believe, carry out a program of research to determine what effects bird control measures have on other wildlife, both immediate and as the result of habitat modifications. Since they are legally obligated to protect these birds, they must also see to it that controls allow for their preservation to perpetuate their beneficial qualities, and to preserve whatever desirable ecological relationship they have with other life forms. Such an agency should be able to evaluate and furnish information on the relation of these birds to other wildlife and to other than agricultural land uses, so that these things may be considered along with agricultural economics.

The interrelationship of all interests to bird depredations control becomes more and more apparent as more and more drastic controls and particularly poisons, are utilized. Cooperation with all agencies and interests, so that all aspects of these problems may be reviewed and considered, and mutually desirable actions taken, is the principle duty of the wildlife agencies. Their primary duty is, of course, to protect the wildlife resource, and because this resource is intimately related to all types of land use there seems to be no logical point at which they may disavow their interest in these matters.

LITERATURE CITED

Neff, J. A. and Brooke Meanley
1957. "Blackbirds and the Arkansas Rice Crop." Ark. Agri. Exp. Sta., Bull. 584. 89 pp.

THE AGRICULTURAL EXPERIMENT STATION IN RELATION TO BIRD DEPREDATIONS

FRANCIS J. WILLIAMS
Arkansas Agricultural Experiment Station, Stuttgart, Arkansas

The job of the Agricultural Experiment Station is to seek ways and means of increasing the efficiency of producing and marketing agricultural products. If this efficiency can be achieved, the consumer will be assured of an abundant and reasonably priced supply of agricultural products.

Since we are interested in the efficiency of crop production, let us look briefly at bird depredations from the viewpoint of the farmer. Farmers in Arkansas are very much concerned about the damage to crops being caused by blackbirds. Various estimates have been made as to the amount of this damage. In 1953 it was estimated that the Arkansas rice crop alone suffered a damage of 1½ to 3 million dollars. A more recent estimate indicated a 5½ million dollar annual loss on all crops in Arkansas.

As indicated by some of the previous speakers, bird depredations are not limited to Arkansas. Officials in Mississippi reported that the rice yield was reduced by 7 to 10% and in some cases much more. Louisiana, Texas and California have reported damage to rice as well as to other agricultural crops. A number of other states have reported damage done by blackbirds to corn, small grains, grain sorghum, peanuts, and fruit and truck crops.

Although the average rice farmer in Arkansas may suffer relatively little loss, a number of individual farmers may receive very severe damage to their crops. As an example, this year a rice farmer in the Stuttgart area reported a yield of only 35 bushels per acre instead of his estimate of 100 bushels per acre before the blackbirds started working on the field. Even the rice which was harvested was of poor quality and brought a greatly reduced price. In addition to the above losses this farmer spent $10.00 per acre trying to frighten the blackbirds away.

It is realized that blackbirds are of some benefit as they glean waste rice, red rice, and grass and weed seeds and harmful insects from the fields. It would be very difficult to place a monetary value on the good done by blackbirds. Some people are of the opinion that the good they do exceeds the amount of damage inflicted. However, it would be difficult to get a rice farmer whose crop has been severely damaged to agree with such a statement.

As far as we can ascertain, relatively little research is being conducted to find ways to combat these pests. The only work Arkansas has underway at present is a search for a repellent material which can be applied to maturing grain sorghum without leaving harmful residue.

You already have heard of the work being done in Ohio as reported by Dr. Giltz. Delaware, in cooperation with the Department of Interior, reported a project underway in an attempt to find ways of reducing losses to blackbirds on corn. Their approach is concerned with resistant varieties, repellants, cultural practices and frightening devices. Virginia reported a similar cooperative project underway in an attempt to find ways of preventing losses to corn, milo, and shocked peanuts. Kentucky has reported severe damage to grain sorghum by blackbirds. Repellants were tried but with little success. These are the only states out of several contacted which reported any research work underway. All of them reported damage.

The U. S. Department of Interior in cooperation with the University of Arkansas conducted research on bird depredations from 1948 through 1955 in the Ricebelt of Arkansas. Studies were undertaken to determine the species of birds involved, their natural history, and their feeding habits. Various methods were tried to combat their attacks on rice. Some of these methods were helpful and are still being used by the Arkansas rice farmer.

Learned from these studies and from observations since the studies were terminated are a number of cultural practices which, in many cases, reduce the damage done to rice by blackbirds. These pests appear to be attracted more to bright, smooth-hulled rice varieties than to dark or rough-hulled ones. Unfortunately, all of our most popular varieties at the present time are the ones which are most attractive.

Early spring seeding invites bird damage to rice in Arkansas. Extremely early maturing or very late maturing individual fields of rice are usually damaged severely. However, due to weather conditions, it is not always possible to plant fields so that they will mature at the desirable time.

At seeding time less damage is likely to occur if all seeds are completely covered. Rice can be successfully seeded by covering with soil or water. Regardless of the method used it is very necessary to cover seeds completely to prevent serious losses by blackbirds. In the case of water seeding it is necessary to keep seeds completely submerged with a uniformly deep flood. In many fields this is impossible because of a relatively steep slope and uneven areas in the field. Also, blackbirds may be attracted to rice seeded on the levees.

Clearing of fence rows and the removal of tall weeds from fields have reduced losses in many cases. Fields which are bordered by woods on one or more sides are usually more severely damaged than fields in the open prairie.

Many different types of frightening devices have been tried and are being used to some extent by the rice farmers at the present time. Some farmers have reported obtaining fair results using these exploders, firecrackers, rifles, and shotguns. However, many farmers indicate that these devices are expensive and often give poor results.

Recently, some of the rice farmers have reported good repellent action when treating rice seed with aldrin. This material was applied in heavy concentrations last year to maturing grain sorghum with poor results, but if the material will repel blackbirds during the seeding period of rice it will be helpful. As yet the repellency action of aldrin has not been confirmed through critical tests by the Experiment Station.

When carried out, all of the cultural practices which I have just mentioned help to reduce the damage caused by blackbirds in many fields. On the other hand, many farmers have received very little, if any, benefit from these practices.

Farmers in Arkansas are very sincere in their belief that ways of eliminating losses to blackbirds must be found. We, at the Experiment Stations feel that our major function is to determine more efficient ways and means of producing and marketing agricultural products. Since certain species of birds have caused rather extensive economic damage to agricultural products, we feel that we have a definite responsibility in determining how losses can be eliminated.

Because of the blackbirds habit of migrating from one state to another and inflicting damage to a number of crops, we, in Arkansas, feel that research should be on a regional basis. To carry this idea a step further, it appears that the depredation problem could be outlined, then broken down into possible jobs, some of which would be done by one agency, some by another, and still others by certain Experiment Stations. Insofar as possible, we are most anxious to cooperate in such a regional program to help work out satisfactory control measures.

In summary, I have said that blackbirds are a serious problem in the production of several crops not only in Arkansas, but in many other states. It is difficult to determine the full amount of damage done, but a recent estimate of damage to crops in Arkansas alone is 5½ million dollars annually. There is no known practical or economical way to prevent these losses. The farmers are demanding that research be initiated in an attempt to find ways of combating this pest. It is felt that the Experiment Stations have a definite responsibility to the farmers to assist him in producing and marketing his products more efficiently. Any research initiated on the problem should be conducted on a regional basis.

RESEARCH ON CONTROL OF BLACKBIRD DEPREDATIONS

JAMES S. LINDZEY

Patuxent Wildlife Research Center, U. S. Fish and Wildlife Service, Laurel, Maryland

This paper reviews the problems in bird-depredation control and outlines the methods research workers are using to solve these problems. Chief attention is being given to redwinged blackbirds *(Agelaius phoeniceus)* and grackles (*Quiscalus* spp.), because of their widespread distribution and their importance in agricultural damage and nuisance problems. Starlings *(Sturnus vulgaris)* and cowbirds *(Molothrus ater)* are also being studied, because they frequently are found with the redwings and grackles and because they themselves sometimes cause appreciable damage or constitute a serious nuisance.

The Bureau of Sport Fisheries and Wildlife, because of its responsibilities for the protection of migratory birds, has an important responsibility for leadership in research on control of bird depredations. This responsibility is shared by agricultural agencies, who conduct research to find ways to protect crops by modifying cultural techniques or by other methods such as the development of bird resistant crop varieties. State conservation organizations also are interested in bird depredations and nuisance problems and wish to encourage the development of damage control methods that cause minimum losses to other wildlife. Public health authorities and others also are concerned in research efforts because of the relationships of birds to human and livestock diseases.

The Bureau of Sport Fisheries and Wildlife conducts research on control of bird damage primarily to aid individual farmers and local communities to better cope with their bird problems in ways acceptable to the public. Our goal is to achieve a modernization of control materials and procedures and some degree of mechanization in their application so that a reasonable degree of efficiency in control can be attained. This is necessary if control is to keep pace with the progress that is being made in other phases of agriculture. A strong public-supported program of bird protection is dependent on providing farmers and others with methods for controlling bird damage that are safe, effective and economical to apply.

Research is of two major types: (1) Projects designed to provide protection without affecting bird numbers, and (2) projects designed to provide protection through control of bird numbers. Most research has dealt with crop protection. The principles involved, however, apply also to protection of trees, buildings, and other installations.

Studies to protect crops through the use of scare devices, repellents, bird-resistant crop varieties, cultural techniques, mechanical barriers and by suitable location and timing of planting have been handicapped by lack of basic knowledge about the biology, habits, movements and ecological relationships of the birds. Hundreds of materials have been screened to determine whether they repel birds, but only meager data are available to show the important physiological basis for repellent action. A research study on the senses of taste and smell in blackbirds was conducted at the University of Massachusetts during 1958. This study showed the difficulty of such basic physiological research, but suggested that repellency was not through the olfactory sense.

Current research on repellents is largely empirical and depends on applying various materials to vulnerable crop seeds and exposing the seeds to birds in small-scale cage tests. Promising repellents then are subjected to phytotoxicity tests to determine whether the materials affect seed germination or the maturing plants. These tests are followed by larger scale enclosure tests and finally by field planting tests. There may be local variations in phytotoxicity due to differences in climate or soil. Variation in field conditions and bird numbers also may cause variations and irregularities in bird attack. Therefore, repellents must be tested in different areas. A repellent good in Florida during the winter was useless in New Jersey during the summer. Another serious problem is to develop satisfactory means of measuring bird damage.

The Bureau has discovered repellents to protect pine seed used for direct seeding as referred to in another paper, and has developed techniques for testing repellents and varietal resistance of plants to bird attack. Standard preliminary procedures have been worked out for testing materials that show promise in initial screening. Damage-appraisal techniques have been developed both for local areas and for large areas. Appraisal by these procedures affords a basis for acceptable damage evaluations and provides a means for deciding on the type of damage control justified.

Several methods of frightening birds from crops are being investigated. These include utilizing playbacks of bird calls, reproducing normal frightening sounds, and producing ultrasonics. In the Bureau and at Ohio State University, research experiences with recorded blackbird calls have suggested a number of possible uses in frightening, attracting or censusing redwings. Frightening of birds for limited periods, or under particular conditions, has been accomplished at the University of Massachusetts by the use of realistic hawk models, which suggests the value of visual frightening techniques. Sparking devices or electric shockers to protect crops and buildings have proven effective, although the sparking devices require further research to eliminate interference with radio signals. Mild shocking devices appear important for further research, particularly where long-term protection of small areas is needed. Paper netting has been effective in protecting small garden plantings or high-value crops in limited areas, which suggests the need of further study of bird exclusion as a protection method.

Despite the success of the various methods for preventing damage without killing the birds, there are times and places where none of these methods is satisfactory. Then, control of the birds themselves may be desirable if it can be achieved safely, economically, and in a manner acceptable to the public. Research on means of reducing bird numbers is being conducted through four different avenues: (1) Direct lethal control by chemicals, (2) removal of birds by mechanical means, (3) indirect population reduction through the use of materials affecting reproduction, and (4) population reduction using biological or ecological mechanisms.

Success in developing techniques for reductional control hinges largely on more information about the numbers, productivity, habits, movements, and migration of the depredating birds than is now available. We do not believe that total control of the continental population is desirable, that it could be achieved within economic or practical reason, or that such a plan would be acceptable to the American public. It is apparent that normal productivity is maintaining the population of depredating birds and that any measures to reduce the continental population would have to be drastic and efficient over a very large area. Further, it is likely that such control would require annual repetition to result in measurable crop savings. We believe, instead, that population reduction must be directed specifically at birds causing damage. Federal regulations permit killing birds when they are committing, or about to commit damage. Present research of the Bureau and other agencies is directed toward finding means of population reduction that can be selectively applied so that the balance of the population can be protected and conserved.

It is extremely difficult to find a chemical that may be used as a paint, spray, gas or general contaminant for controlling local populations of birds. Birds are not as easy to kill as might be imagined. Although the blackbirds appear quite vulnerable because they concentrate in roosts, a review of hundreds of candidate materials has yielded only a few that may have application in specific and limited circumstances. The problem lies in finding a material and method of application that will quickly and humanely dispatch the blackbirds without serious hazard to humans, livestock, and other wildlife or plant life. This is an imposing problem, in part because of the lack of data concerning specific physiological weaknesses in the birds that might make them subject to specific control. Limited research on this physiological problem is being conducted at the University of Massachusetts by Bureau personnel and University cooperators. The Bureau, aided by cooperating bird banders, University staff under contract to the Bureau and other organizations, is seeking data on bird numbers, productivity, and movements, so that when control techniques are found they can be applied where crop savings will result. This would most logically be at summer concentrations during the damage period, but might be at winter roosts if clear relationships between the birds in the roost and damage were demonstrable.

Killing with poisoned baits has some potential usefulness, but generally is not feasible for crop protection. Research is largely directed to developing the potential usefulness of bait poisoning for controlling nuisance or depredating birds such as starlings, pigeons and sparrows in limited areas, such as livestock feed lots or the vicinity of grain elevators.

Mechanical means of removing birds have many favorable aspects, including good individual and public acceptance, because the birds so captured often can be utilized for scientific specimens, food, fertilizer or other purposes, whereas chemical killing generally renders further use impractical. The floodlight trap, which has been used successfully at winter roosts to capture thousands of starlings, grackles and cowbirds, is the best example of this technique, and has proved selective in capturing only the problem species. An important present value of this trap is in making thousands of birds available for banding or band recovery so that movements and migrations in relation to damage can be traced.

A more subtle approach, but perhaps in time a very useful technique, is the research to find a means for selectively reducing productivity. Research contracted by the Bureau to Johns Hopkins University is concerned with one material that has been shown to reduce gametogenesis in the starling. Experimental field application of this material to wild birds is planned. Another material is being studied at the University of Massachusetts. This material has shown promise in affecting gonadal activity and the characteristics of eggs produced. Even if a satisfactory material becomes available, means of getting it into the birds, and of using it selectively so that other valuable birdlife will not be affected, pose serious problems.

Biological and ecological population control present fascinating possibilities. Chief hope for biological control mechanisms lies in the viruses, if a virus can be found for each depredating species that will be so host specific that it will not endanger other birds, and if a manner of culturing and using it can be found that will not literally jeopardize the species. The great number of diseases and parasites present in the blackbirds, coupled with the birds' apparent ability to maintain a sizable vigorous population despite the diseases, suggests the difficulty in these studies. Cornell University and Virginia Polytechnic Institute are working under contract with the Bureau in assembling data concerning the potential usefulness of ecological management in reducing crop hazard and management measures which may affect productivity. Ohio State University has gathered interesting and potentially valuable information on redwing nesting in hay fields.

CONCLUSION

Research concerning the basic biology and ecology of depredating birds is being strengthened because such knowledge is an essential, but currently weak basis for proper management of depredating and nuisance birds. Agricultural research, coordinated with biological data about depredating birds, is needed in developing bird-resistant crop varieties and cultural practices to reduce losses due to bird attack. Research to reduce bird damage and nuisance is divided into studies of methods which do not affect bird numbers and methods which will reduce numbers of birds. Emphasis is given to development of methods for avoiding damage, because of the importance of protecting the birds for their positive values.

Although the economic, social and general demands man is making on his environment continue to throw him into conflict with birdlife, research gains indicate that major conflicts between man and depredating birds can be resolved and that reasonable and beneficial populations of the so-called depredating and nuisance species can be maintained.

PUBLIC HEALTH IN RELATION TO BIRDS: ARTHROPOD-BORNE VIRUSES

HARALD NORLIN JOHNSON, M.D.[1]

Viral and Rickettsial Disease Laboratory, California State Department of Public Health, Berkeley

The arthropod-borne viruses exist in nature as parasites of wildlife. Certain hematophagous arthropods such as mosquitos and ticks become infected from the reservoir wildlife host by taking up the virus with their blood meal, and after an incubation period they can transmit the virus to a new susceptible host in the course of taking another blood meal. The public health problem as regards birds arises from the fact that they are susceptible to infection with some of the arthropod-borne viruses which can also infect man or domestic animals. Of these, Western equine, Eastern equine, St. Louis, Japanese B, West Nile and Sindbis viruses have been isolated from wild birds. The geographical distribution of these viruses and their cycles of activity in mosquitos and birds indicate that these viruses are carried from one region to another by migratory birds and that the wild bird host is the main source of the virus during epidemics caused by these viruses.

In a discussion of the ecology of parasitic infections in wildlife, we must consider the long term history of a parasite in nature. A parasite seldom produces disease and death in the reservoir host. One can expect that the natural host or complex of hosts is not uniformly parasitized and that the relative susceptibility to disease is therefore variable in the host species, depending on constant, intermittent or no prior exposure to the parasite in the history of the species. For example, prior experience with the parasite may have eliminated the more susceptible individuals, so that the infection is asymptomatic even if acquired after sexual maturity; or infection of the young before they lose the passive immunity inherited from the mother animal will result in an asymptomatic infection which immunizes the individual against subsequent exposure to the parasite. It is during the

[1]Director, Arthropod-Borne Virus Studies, Viral and Rickettsial Disease Laboratory, California State Department of Public Health, Berkeley. This is a joint project of The Rockefeller Foundation and the California State Department of Public Health.

periodic rapid extension of the parasitic infection in the normal host or complex of hosts that we may observe disease on a scale large enough to be noticed by man. Extension of a parasite into aberrant hosts may produce severe epidemics of disease, for example, when rabies virus is introduced into the coyote, fox or striped skunk species, *B. tularensi* bacteria into wild rabbits, and *B. pestis* bacteria into ground squirrels or Norway rats. The spread of such parasites to man or domestic animals is apt to produce a characteristic disease syndrome.

The history of arthropod-borne virus diseases in the United States can be illustrated best by reviewing our knowledge of horse encephalitis which we now know is caused by two members of this group of viruses. The modern domestic horse is an introduced species in the Americas and it is therefore an aberrant host for the American arthropod-borne viruses. This may explain why the horse is so susceptible to disease when exposed to these viruses. The history of horse encephalitis in the United States goes back to 1831 when there was a small epidemic involving about 75 horses in the vicinity of Middleboro, Massachusetts (Hanson, 1957). The symptomatology of arthropod-borne equine encephalitis is sufficiently characteristic that there is little doubt that this epidemic was caused by the same virus which was isolated from horses in this region in 1938 (Schoening et al., 1938). In 1908 there was an outbreak of equine encephalitis in Louisiana in the same region where there have been recent epidemics of this disease and where one type of arthropod-borne virus was isolated from horse brain specimens (Mohler, 1941; Howitt et al., 1948). The first large-scale epidemic of horse encephalitis developed in central United States in 1912 and the disease was called the Kansas-Nebraska horse plague. The horse plague recurred in a larger area of central United States in 1918-1919, and since that time there have been cases reported each year in this region (Mohler, 1941). The major epidemics of the disease have been associated with the cyclical periods of unusually heavy rainfall. The development of large-scale irrigation projects in the grasslands of North America appears to have furnished the same ecological conditions as the periods of high rainfall, and horse encephalitis has been an annual problem in one or another of the irrigated regions of western United States since 1919. In eastern and southern United States the epidemics of horse encephalitis have originated in agriculturally developed communities in the vicinity of large swamps.

In 1930 there occurred an unusually severe epidemic of horse encephalitis in the Central Valley of California; the causative virus was isolated from the brain tissue of diseased horses and named Western equine encephalomyelitis virus (Meyer et al., 1931). There was no prior history of the disease in California except for the tradition among the Indians that horses kept in certain of the northern river valleys were subject to brain fever. In 1933 it was discovered that *Aedes aegypti* mosquitos could transmit Western equine virus from one animal to another and to a horse, after a suitable incubation period (Kelser, 1933).

In August and September of 1933 there was an epidemic of horse encephalitis in Virginia, Delaware and New Jersey. The virus isolated from diseased horses during this epidemic proved to be different from Western equine virus and it was called Eastern equine encephalomyelitis virus (TenBroeck and Merrill, 1933; Giltner and Shahan, 1933). In 1934 it was reported that the Eastern equine virus could be transmitted from one horse to another by a local marsh mosquito, *Aedes sollicitans* (Merrill et al., 1934). It was noted that the horse cases of encephalitis were for the most part from marshy areas, and the theory was postulated that birds might be the natural hosts for the virus (TenBroeck et al., 1935).

The first isolation of an arthropod-borne virus from wild birds was in 1938 when Eastern equine virus was isolated from ring-necked pheasants and a pigeon (VanRoekel and Clarke, 1939; Tyzzer et al., 1938; Fothergill and Dingle, 1938a). The birds were tested for virus because they were found sick, the pheasants on September 16 and October 6 and the pigeon on September 20. There were two cases of horse encephalitis on the farm where the sick pigeon was found. There have been repeated epidemics of Eastern equine virus encephalitis in ring-necked pheasants raised commercially on pheasant farms in New Jersey (Beaudette and Black, 1948). This game bird is an introduced species in the United States, and it is a good sentinel host for detecting the presence of Eastern equine virus.

In 1937 and 1938 there was an unusually high incidence of equine encephalitis in the great central plains states of United States and Canada. The extensive mortality in horses from this disease is regarded as the stimulus that resulted in the development of tractor farming at this time. In 1938 both Western equine virus and Eastern equine virus were isolated for the first time from the brain tissue of persons who had died of encephalitis, a fact which showed that these viruses could produce encephalitis in man as well as in horses (Howitt, 1938; Fothergill et al., 1938b; Webster and Wright, 1938).

In 1940 and 1941 there was another widespread epidemic of encephalitis in man and horses in central and western United States and Canada. One description of this outbreak listed 2823 cases of human encephalitis, of which 434 were in Manitoba, 64 in Montana, 1080 in North Dakota, 815 in Minnesota, 180 in South Dakota and 250 in Nebraska. It was observed that the disease was epidemic in horses in North Dakota in 1937, and the following year there was an epidemic of encephalitis in man and there were but relatively few cases of encephalitis in horses (Leake, 1941). In 1941 both Western equine virus and St. Louis virus were isolated from mosquitos collected in nature in Yakima Valley, Washington (Hammon et al., 1941a). This was the first definite proof that mosquitos were natural vectors for these viruses. A study of the epidemiological aspects of the Yakima Valley epidemic showed that this epidemic was caused by two different viruses; that is, some cases of encephalitis were caused by Western equine virus and some by St. Louis virus (Hammon and Howitt, 1942). It was noted that the distribution of cases followed that of the orchards rather than that of irrigated land in general. The peak of the epidemic was in the middle of August. A study of blood sera from mammals and birds collected during the Yakima Valley epidemic showed serological evidence of prior infection with both Western equine virus and St. Louis virus in horned owls, sparrow hawks and quail. Killdeers showed evidence of immunity to Western equine virus and mourning doves to St. Louis virus. One of eight meadow mice, *Microtus montanus,* one of four deer mice, *Peromyscus maniculatus,* and two of three weasels, *Mustela frenata,* showed evidence of immunity to Western equine virus (Hammon et al., 1941b). These studies indicated that both wild birds and small mammals were infected with Western equine virus but suggested that the birds were the more likely source of virus for the infection of mosquitos during the epidemic.

Western equine virus was isolated from a prairie chicken, *Tympanuchus cupido americanus,* shot August 27, 1941 near Rugby, N. D., during a field study of the epidemic of encephalitis in man and horses which occurred in this area that year (Cox et al., 1941). This was the first isolation of Western equine virus from wild birds. Eastern equine virus was isolated from the brain of a horse that died of encephalitis on April 29, 1941 in the Boca Chica flat area near Brownsville, Texas (Randall and Eichhorn, 1941). This was one of 60 cases of horse encephalitis observed in this region. The Boca Chica flat area is in the center of a major flyway of migratory birds.

The Eastern equine virus was not isolated from wild caught mosquitos until 1948 when the virus was obtained from *Mansonia perturbans* mosquitos collected in Georgia in a region where there were cases of horse encephalitis (Howitt et al., 1949). The same virus was isolated from *Culiseta melanura* mosquitos collected in Louisiana in August 1950 (Chamberlain et al., 1951). In western United States the *Culex tarsalis* mosquito is the main vector of both Western equine virus and St. Louis virus during the epidemic cycle of the virus.

In 1950 Western equine virus was isolated from the blood specimens of two redwinged blackbird nestlings, collected near Nunn, Colorado between June 26 and June 30, and from the blood of a magpie nestling collected near Greeley, Colorado on June 29 (Sooter et al., 1951). Eastern equine virus was isolated from the blood of a purple grackle shot June 19, 1950 at Manchac swamp, Ponchatoula, Louisiana (Kissling et al., 1951). Since that time there have been many isolations of Eastern equine virus and Western equine virus from wild birds. Two isolations of Western equine virus were obtained in 1953 from immature English sparrows collected at a pheasant ranch in New Jersey during an outbreak of pheasant encephalitis (Holden, 1955).

A large-scale study of wild birds and their role in the ecology of arthropod-borne viruses was conducted in eastern and southern United States by personnel of the U. S. Public Health Service during the years 1953-1957 (Stamm, 1958). In the course of a field study conducted at Hockamock swamp, Massachusetts, Eastern equine virus was isolated from a catbird collected there in September 1953, and from two pigeons, one English sparrow and one lesser yellowlegs collected between August 30 and September 9, 1956. In 1956 a field study was made of the pheasant ranch in New Jersey where the two isolations of Western equine virus were obtained from sparrows in 1953. Tests of 109 wild birds collected in this area in July 1956 were negative for virus, but Western equine virus was isolated from two English sparrows of 12 collected on August 13, and Eastern equine virus from a Carolina chickadee and a yellow-throated vireo of a sample of 19 birds collected August 15. Of 13 birds collected August 16, Eastern equine virus was isolated from an eastern kingbird, and Western equine virus was obtained from a yellow-throated vireo. The next collection in this area was done on August 30. Eastern equine virus was obtained from a Carolina chickadee of a sample of 20 birds. On August 31 a total of 31 birds was taken and Eastern equine virus was obtained from a Carolina wren and Western equine virus from a red-eyed vireo. On September 1 a collection of 28 birds yielded one strain of Eastern equine virus from a northern water thrush. On September 2 a collection of 24 birds yielded one isolation of Eastern equine virus from a Carolina chickadee and one isolation of Western equine virus from an easter phoebe. On September 3 only three birds were collected but Western equine virus was isolated from a crow. All of the 54 birds collected in November were negative for virus. This study is reviewed in detail because it shows that the virus was widely distributed in wild birds during the epidemic season but that there was no evidence of virus activity in the birds taken prior to or after the epidemic.

Another field study was done in Baldwin County, Alabama in 1957 in a region where there have been cases of horse encephalitis. Birds were collected from May through September. Eastern equine virus was isolated from a white-eyed vireo collected on July 31, from a cardinal collected August 2 and from a Kentucky warbler collected August 28. The 106 birds collected between September 24 and 26 were all negative for virus. In the Louisiana Manchac swamp study area, Eastern equine virus was isolated from a mockingbird collected in March 1956 and from a nestling yellow-crowned night heron taken in May 1956. Western equine virus was isolated from a purple grackle collected in May 1956.

In studies of wild birds in California, we have isolated 23 strains of Western equine virus from wild birds tested in this laboratory. The first of these isolations was obtained from an English sparrow nestling collected in Kern County on August 10, 1954. In 1955 we obtained the same virus from two barn swallow nestlings, one collected on August 4 and the other on August 11, and from a young Mexican house finch collected on August 22. The following year an intensive study of nestling birds was done in this area, and from June 22 to July 25 a total of 17 isolations of Western equine virus were obtained from nestling birds, 15 from English sparrows and 2 from barn swallows. Three of the isolations of Western equine virus were obtained from sparrow nestlings found dead in the nest. In addition to the isolations of Western equine virus from nestling wild birds, we also isolated this virus on three occasions from sentinel baby chicks exposed in nature in the study area between July 20 and August 10. We were unable to isolate any virus from immature English sparrows collected during the fall of that year or from nestling sparrows collected the following spring. In 1957 two isolations of Western equine virus were obtained from nestling English sparrows collected on July 29 in the same study area. No attempt was made to repeat the large scale study of 1956.

We can now regard the strains of Western equine virus and St. Louis virus isolated from mites collected from wild bird nests as having come from the nestling birds in those nests, because subsequent studies have shown that the viruses do not persist or multiply in the mites which were tested. With this in mind, it is of interest to note that both Western equine virus and St. Louis virus were isolated from mites obtained from the nest of a yellow headed blackbird taken on June 21, 1946; Western equine virus from mites obtained from the nest of a Brewer blackbird on June 6, 1947; St. Louis virus from mites obtained from the nest of a tricolored blackbird on July 20, 1948; and Western equine virus from mites obtained from the nest of a tricolored blackbird on June 29, 1949 (Reeves et al., 1955). All of these collections were from Kern County, California. The yellow-headed blackbird and tricolored blackbird nests were in tule marshes. The consistency of isolations of virus from this ecological environment from year to year is remarkable.

Although most of the studies relating wild birds to arthropod-borne viruses have concerned the equine encephalitis viruses, we know that St. Louis virus also can be found in wild birds. This virus was isolated first from human brain specimens obtained during the epidemic of encephalitis which occurred in St. Louis in 1933 (Muckenfuss et al., 1933; Webster and Fite, 1933). It should be noted here that St. Louis is in the center of a major flyway of migratory birds. St. Louis encephalitis was not regarded as an arthropod-borne disease until the St. Louis virus was isolated from mosquitos and related to human cases of encephalitis in Yakima Valley, Washington (Hammon et al., 1941a; Hammon and Howitt, 1942). St. Louis virus was isolated from a fledgling mourning dove collected in Kern County, California on August 18, 1955, from a flicker collected in Kentucky and a green heron collected in Haiti in 1955, and from a nestling rusty dove collected in Trinidad in 1956 (Reeves, 1960; Ranzenhofer et al., 1957; Downs et al., 1957).

In addition to the three viruses isolated in wild birds in these studies, three more arthropod-borne viruses have been isolated from wild birds in other parts of the world. In Japan 35 isolations of Japanese B virus were obtained from black-crowned night herons, 16 from plumed egrets and 3 from little egrets collected from July 25 to September 6, during the period 1952-1956 (Buescher et al., 1959). Sindbis virus was isolated from a hooded crow collected in Egypt in 1953 (Taylor et. al., 1955). In India, Sindbis virus was isolated from white wagtails collected in Bombay State in October 1953 and from hill mynas collected in Travancore-Cochin State in December 1953 (Shah et al., 1960). The white wagtails breed in the far north and migrate to India in large numbers in the fall. West Nile virus was isolated from a hooded crow and rock pigeon collected in Egypt in 1953 and from a crombec warbler collected in Tongaland, Union of South Africa, in 1958 (Work et al., 1953; Kokernot and McIntosh, 1959). Regarding the distribution of arthropod-borne viruses in South America, we know that Western equine virus has been active in Argentina from time to time since it was isolated in Argentina in 1933 (Howitt, 1935). Eastern equine virus has been active in the Dominican Republic, Mexico, Cuba, Panama and Brazil (Olitsky and Casals, 1959).

Now to discuss the probable role of wild birds in the propagation and dissemination of the arthropod-borne viruses. The mosquitos which are know vectors during epidemics of the viruses show a preference for feeding on birds, and the evidence is very good that the mosquitos that transmit the viruses to man become infected first from feeding on birds. In California the English sparrow appears to be the major source of the virus in urban areas, but there is no evidence that the virus persists in this species from year to year. The Brewer and redwinged blackbirds have the population numbers and ecology which make them suitable for introducing the viruses into the irrigated farmlands of the Central Valley of California during the summer. (Figure 1). It will be noted from the data given previously that the equine encephalitis viruses are found in birds after the nesting season of most wild birds has been completed and the viruses have not been found in birds during the spring nesting season of English sparrows or barn swallows in California, although Western equine virus was found in these birds during a second nesting period.

To those who have studied the seasonal movement of blackbirds in the United States, it is evident that they must be important hosts for the dissemination of the arthropod-borne viruses in this country. In the eastern part of the United States, the grackles and starlings are in mass migration from north to south just prior to and during the period when Eastern equine virus has been isolated from wild birds. It is not uncommon to observe several thousand of these birds arriving in a wooded area at dusk to roost for the night. The population of blackbirds in some places may reach several million birds. These birds tend to roost in swampy areas. It has been noted previously that the Eastern equine virus has been isolated from grackles, and Western equine and St. Louis viruses isolated from the mites that had been feeding in blackbird nests. In California the isolations of Western equine and St. Louis viruses from birds have been obtained coincident with the migration of Brewer and redwinged blackbirds. This migration begins early in the summer and continues through the winter. The blackbirds which breed in the foothills complete their nesting earlier than those which breed in the valley. This offers an explanation as to how a virus could be transported from the foothill environment to the valley in the early part of the summer. There is also an influx of redwinged blackbirds from Canada in the fall. It would be possible for both Western equine and St. Louis viruses to cycle in blackbirds during the fall flocking of these birds. They tend to move from one irrigated pasture or marsh to another and the mosquitos infected by one flock could serve to move the virus to flocks which come later. Further study of the ecology of blackbirds

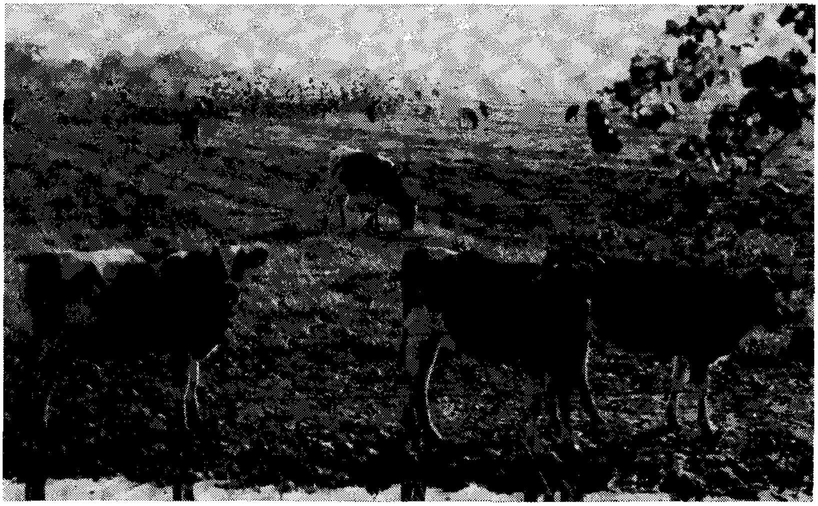

Figure 1. Flock of Brewer blackbirds feeding in an irrigated pasture near Patterson, California, September 29, 1959.

is needed and these birds should be tested for virus during the migration season (Figure 1).

It was noted that there was an isolation of Western equine virus from a house finch collected in California on August 22, 1955. This is the time when the house finches flock in the Central Valley and migrate to the mountains. Western equine virus has been isolated from tree squirrels and ground squirrels found paralyzed or sick during the fall months in California (Lennette et al., 1956). The late seasonal pattern of the Western equine virus infection in tree squirrels and the paralytic nature of the infection suggest that these animals are aberrant hosts and that the virus is carried to their habitat by the house finches when they migrate to the mountains in the fall.

The isolation of Western equine virus from barn swallow nestlings collected during the second nesting period indicates that it would be possible for these birds to move this virus to South America during their southward migration in September. The barn swallows which nest in California might be expected to seek the same ecological environment in the Southern Hemisphere in the winter, in which case their destination would be northern Argentina. There have been epidemics of Western equine encephalitis in this part of Argentina. We know that barn shallows can be observed in migration along the flyways in southern United States for a period of six weeks in the spring and fall, yet the arrival and departure from any one breeding area is remarkably constant. This indicates that barn swallow flocks will be moving along marshes day by day for several weeks, thus providing a means for the transfer of the virus from one flock to another. There is an extensive movement of migratory birds from North America to South America and back each year. There is no good estimate of the population of any of the migratory species but observation of the movement in any one flyway will reveal that the population numbers of some species are enormous.

There seems to be little question that birds are important hosts for the epidemic cycle of several of the arthropod-borne viruses, and under certain circumstances, especially in the tropical and semitropical regions, one can expect the virus to continue to move from bird to bird for an extended period. It is difficult to believe that this occurs in northern United States which has been the scene of persistent activity of Western equine virus. It is easy to say that there have been no isolations of this virus from small mammals other than squirrels but there have been no large-scale studies of small mammals in an effort to find the virus. The squirrels were tested because of the possibility that they might have had rabies. We can expect that the focus of the parasite in nature may be far removed from some of the known areas of epidemic activity because the parasite can be carried from one region to another by migratory birds.

The reason for exploring new leads in the search for the reservoir host for Western equine virus, as well as other mosquito-borne viruses, is that the bird-mosquito-bird cycle is of such a short duration in nature in the Temperate Zone that it does not seem adequate to maintain the virus in nature. It is possible for the virus to move to the tropics with the migratory birds, and this evidently occurs from time to time; for example, some of the data given previously indicates that Eastern equine virus has continued its bird-mosquito-bird cycle during the winter in the tropics and returned in birds via the Boca Chica flyway to infect horses in Texas. Nevertheless, this virus has a seasonal epidemic occurrence in Massachusetts and New Jersey which cannot be explained satisfactorily by the theory that the virus is introduced from the tropics. There is no evidence of survival of the virus from year to year in the foci of epidemic activity.

The natural focus of a parasite is likely to be found in a stable natural ecological environment and not in agriculturally developed land. The epidemiology of several of the arthropod-borne virus diseases suggests that the margin of the forest and grassland of the mountain ranges and high plateaus is the real focus of these viruses as well as many other kinds of parasites. Here there is an abundant and relatively stable population of small mammals and birds. Disturbance of this environment by fire or wood cutting may produce ecological changes leading to variation in the population of both arthropods and vertebrates, and this would be expected to have something to do with the spread and regression of the parasite in the natural host as well as in aberrant hosts. River courses and flood plains would provide for a greater diversity of arthropods and birds for the dispersion of the parasite to new hosts. It is necessary to be alert to disease in wild animals in areas subject to sudden ecological disturbances and to collect arthropods in such regions for virus studies. In the search for a virus in vertebrates, it is not enough to test the blood, because it has been found in this laboratory that Western equine and St. Louis viruses tend to localize in the pancreas and kidney after the virus leaves the blood stream, and the virus may be found in the lactating breast tissue of experimentally infected mice during the post viremic phase of the infection. This offers a means other than arthropod transmission for the survival of a virus in the small mammal host. We have isolated a virus called Rio Bravo virus from the salivary glands of asymptomatic Mexican freetail bats, *Tadarida mexicana,* and another virus called Modoc virus from the breast tissue of a deer mouse, *Peromyscus maniculatus.* Serological tests have shown that these viruses are related to the group B arthropod-borne viruses and so we know that some viruses of this type can survive in small mammals without producing disease. It also reminds us that we must consider the possibility that migratory insectivorous bats may move arthropod-borne viruses from one region to another. It is my opinion that wild birds are aberrant hosts for the arthropod-borne viruses and that the real reservoir of these viruses is to be found in small mammals.

History teaches us that epidemics of mosquito-borne encephalitis did not occur in the United States until man exploited large areas of lowland for agriculture. This led to changes in the ecology of mosquitos, birds and mammals which precipitated aberrant cycles of virus activity which we can assume are of no importance to the long-term survival of the arthropod-borne viruses in nature. For example, the draining and subsequent irrigation and cultivation of most of the marshland of the floodplains of our great river systems have almost eliminated the natural reed and rush habitat of blackbirds, swallows and bats. A small amount of marshland has been set aside as State and Federal wildlife refuges but these are overcrowded. Blackbirds have been forced to feed on irrigated grain, cotton, alfalfa and grass pasture fields. This has its economic advantages as well as disadvantages. These birds also are attracted to large-scale farming operations, where there are feedlots for cattle, because they can obtain a ready source of food. This appears to be the means for the introduction of arthropod-borne viruses into local colonies of wild birds such as sparrows and finches and also into domestic flocks of chickens.

The ecological approach to the problem is to direct the disease control effort at the arthropod vector because of the economic importance of the insectivorous birds in the biological control of harmful insect pests.

LITERATURE CITED

Beaudette, F. R., and Black, J. J.
1948. Equine encephalomyelitis in New Jersey pheasants in 1945 and 1946. J. Am. Vet. Med. Assn., 112:140-147.

Buescher, E. L., Scherer, W. F., McClure, H. E., Moyer, J. T., Rosenberg, M. Z., Yoshii, M. and Okada, Y.
1959. Ecologic studies of Japanese encephalitis virus in Japan IV. Avian infection. Am. J. Trop. Med. & Hyg., 8:678-688.

Chamberlain, R. W., Rubin, H., Kissling, R. E., and Eidson, M. E.
1951. Recovery of virus of Eastern equine encephalomyelitis from a mosquito, *Culiseta melanura* (Coquillett). Proc. Soc. Exp. Biol. & Med., 77:396-397.

Cox, H. R., Jellison, W. L., and Hughes, L. E.
1941. Isolation of Western equine encephalomyelitis virus from a naturally infected prairie chicken. Pub. Health Rep., 56:1905-1906.

Downs, W. G., Anderson, C. R., and Casals, J.
1957. The isolation of St. Louis virus from a nestling bird in Trinidad, British West Indies. Am. J. Trop. Med. & Hyg., 6:693-696.

Fothergill, L. D., and Dingle, J. H.
1938a. Fatal disease of pigeons caused by virus of eastern variety of equine encephalomyelitis, Science, 88:549.

Fothergill, L. D., Dingle, J. H., Farber, S., and Connerley, M. L.
1938b. Human encephalitis caused by the virus of the eastern variety of equine encephalomyelitis. New England J. Med., 219:411.

Giltner, L. T., and Shahan, M. S.
1933. Transmission of infectious equine encephalomyelitis in mammals and birds. Science, 78:63.

Hammon, W. McD., Reeves, W. C., Brookman, B., and Izmui, E. M.
1941a. Isolation of the viruses of Western equine and St. Louis encephalitis from *Culex tarsalis* mosquitoes. Science, 94:328-330.

Hammon, W. McD., Gray, J. A., Evans, F. C., Izmui, E., and Lundy, H. W.
1941b. Western equine and St. Louis encephalitis antibodies in the sera of mammals and birds from an endemic area. Science, 94:305-307.

Hammon, W. McD., and Howitt, B. F.
1942. Epidemiological aspects of encephalitis in the Yakima Valley, Washington: Mixed St. Louis and Western equine types. Am. J. Hyg., 35:163-185.

Hanson, R. P.
1957. An epizootic of equine encephalomyelitis that occurred in Massachusetts in 1831. Am. J. Trop. Med. & Hyg., 6:858-862.

Holden, P.
1955. Recovery of Western equine encephalomyelitis virus from naturally infected English sparrows of New Jersey, 1953. Proc. Soc. Exp. Biol. & Med., 88:490-492.

Howitt, B. F.
1935. An immunological study in laboratory animals of thirteen different strains of equine encephalomyelitis virus. J. Immunology 29:319-341.

Howitt, B.
1938. Recovery of the virus of equine encephalomyelitis from the brain of a child. Science, 88:455-456.

Howitt, B. F., Bishop, L. K., Gorrie, R. H., Kissling, R. E., Hauser, G. H., and Trueting, W. L.
1948. An outbreak of equine encephalomyelitis, eastern type, in southwestern Louisiana. Proc. Soc. Exp. Biol. & Med., 68:70-72.

Howitt, B. F., Dodge, H. R., Bishop, L. K., and Gorrie, R. H.
1949. Recovery of the virus of Eastern equine encephalomyelitis from mosquitoes (*Mansonia perturbans*) collected in Georgia. Science, 110:141-142.

Kelser, R. A.
1933. Mosquitoes as vectors of the virus of equine encephalomyelitis. J. Am. Vet. Med. Assn., 82:767.

Kissling, R. E., Rubin, H., Chamberlain, R. W., and Eidson, M. E.
1951. Recovery of virus of Eastern equine encephalomyelitis from blood of a purple grackle. Proc. Soc. Exp. Biol. & Med., 77:398-399,

Kokernot, R. H., and McIntosh, B. M.
1959. Isolation of West Nile virus from a naturally infected human being and from a bird, *Sylvietta rufescens* (Vieillot). South African Med. J., 33:987-989.
Leake, J. P.
1941. Epidemic of infectious encephalitis, Public Health Rep., 56:1902-1905.
Lennette, E. H., Ota, M. I., Dobbs, M. E., and Browne, A. S.
1956. Isolation of Western equine encephalomyelitis virus from naturally-infected squirrels in California. Am. J. Hyg., 64:276-280.
Merrill, M. H., Lacaillade, C. W., and TenBroeck, C.
1934. Mosquito transmission of equine encephalomyelitis. Science, 80:251-252.
Meyer, K. F., Haring, C. M., and Howitt, B.
1931. The etiology of epizootic encephalomyelitis of horses in the San Joaquin Valley, 1930. Science, 74:227-228.
Mohler, J. R.
1941. Brief history of infectious equine encephalomyelitis and related affections in the United States. J. Am. Vet. Med. Assn., 98:451-453.
Muckenfuss, R. S., Armstrong, C., and McCordock, H. A.
1933. Encephalitis: Studies on experimental transmission. Pub. Health Rep., 48:1341-1343.
Olitsky, P. K., and Casals, J.
1959. Chapter 13, Arthropod-borne Group A virus infections of man. Viral and Rickettsial Infections of Man, 3rd Edition, Rivers & Horsfall, J. B. Lippincott Company, N. Y.
Randall, R., and Eichhorn, E. A.
1941. Westward spread of eastern type equine encephalomyelitis virus. J. Am. Vet. Med. Assn., 98:448.
Ranzenhofer, E. R., Alexander, E. R., Beadle, L. D., Bernstein, A., and Pickard, R. C.
1957. St. Louis encephalitis in Calvert City, Kentucky, 1955. An epidemiologic study. Am. J. Hyg., 65:147-161.
Reeves, W. C., Hammon, W. McD., Doetschman, W H., McClure, H. E., and Sather, G.
1955. Studies of mites as vectors of Western equine and St. Louis encephalitis viruses in California. Am. J. Trop. Med. & Hyg., 4:90-105.
Reeves, W. C.
1960. Personal communication.
Schoening, H. W., Giltner, L. T., and Shahan, M. S.
1938. Equine encephalomyelitis produced by inoculation of human encephalitis virus. Science, 88:409-410.
Shah, K. V., Johnson, H. N., Rao, T. R., Rajagopalan, P. K., and Lamba, B. S.
1960. Isolation of five strains of Sindbis virus in India. Indian J. Med. Research, 48(3):300-308.
Sooter, C. A., Howitt, B. F., Gorrie, R., and Cockburn, T. A.
1951. Encephalitis in Midwest IV. Western equine encephalomyelitis virus recovered from nestling wild birds in nature. Proc. Soc. Exp. Bol. & Med., 77:393-394.
Stamm, D. D.
1958. Studies on the ecology of equine encephalomyelitis. Am. J. Pub. Health, 48:328-335.
Taylor, R. M., Hurlbut, H. S., Work, T. H., Kingston, J. R., and Frothingham, T. E.
1955. Sindbis virus: A newly recognized arthropod-transmitted virus. Am. J. Trop. Med. & Hyg., 4:844-862.
TenBroeck, C., and Merrill, M. H.
1933. A serological difference between Eastern and Western equine encephalomyelitis virus. Proc. Soc. Exp. Biol. & Med., 31:217-220.
TenBroeck, C., Hurst, E. W., and Traub, E.
1935. Epidemiology of equine encephalomyelitis in the eastern United States. J. Exp. Med., 62:677-685.
Tyzzer, E. A., Sellards, A. W., and Bennett, B. L.
1938. The occurrence in nature of "equine encephalomyelitis" in the ringnecked pheasant. Scienc, 88:505-506.
VanRoekel, H., and Clarke, M. K.
1939. Equine encephalomyelitis virus (eastern type) isolated from ringnecked pheasant. J. Am. Vet. Med. Assn., 94:466-468.
Webster, L. T., and Fite, G. L.
1933. A virus encountered in the study of material from cases of encephalitis in the St. Louis and Kansas City epidemic of 1933. Science, 78:463-465.
Webster, L. T., and Wright, F. H.
1938. Recovery of Eastern equine encephalomyelitis virus from brain tissue of human cases of encephalitis in Massachusetts. Science, 88:305-306.
Work, T. H., Hurlbut, H. S., and Taylor, R. M.
1953. Isolation of West Nile virus from hooded crow and rock pigeon in the Nile Delta. Proc. Soc. Exp. Biol. & Med., 84:719-722.

PROBLEM BIRDS

CARL W. BUCHHEISTER
President, National Audubon Society, New York City

I did not select the title for my portion of this presentation, and since I am not an ornithologist but the spokesman for a national membership organization devoted to wildlife conservation and to conservation education, I trust you will allow me the privilege of adapting my remarks to represent the views of the National Audubon Society in this controversial area of wildlife conservation.

As many of you know, the National Audubon Society has had a long experience with America's wildlife conservation problems. We roused the nation to put a stop to commercial traffic in wild bird plumage, and I think it safe to say that many professional wildlifers will agree that this Society has played an important role in working for the conservative management of our wildlife resources. The notion that we oppose hunting is not true. However, in those cases where we feel that the biology of the situation requires more regulation of hunting pressure, we have not hesitated to request it. We are, also, practically the only spokesman for non-game bird conservation. Unfortunately, the human population growth of the last decade, especially, and the consequent emphasis on economic development are posing many new problems. Today's topic on problem birds is one of special interest in that it epitomizes the new problems we face.

An important basis for understanding any problem in its entirety, and for reaching a practical solution or compromise, is to view it in perspective.

We took part in the preliminary hearing on this topic in Washington last August; we have kept an eye on press reports; and have, of course, discussed it with a number of consultants.

The first point to make seems to me that the claims of increase in blackbird numbers have as yet little or no foundation in fact. There is no question that the starling has increased, but redwings and grackles may or may not be more numerous than they were twenty years ago when I spent more time in the field. We do recognize that there is more depredation from fall concentrations of blackbirds, but we suggest that this may be due not so much to an increase of blackbirds but, rather, to the increase of certain agricultural practices that tend to "bait" these birds. These are two very different sources of trouble and ought to be considered separately as such.

Before trying to examine this conflict of interest more closely, let me point out certain things that may at first seem to be unrelated to this problem, but which we feel belong in any policy considerations.

As of December 1959 we are told that only two States in the union were free of insecticide-resistant insects. Increasing numbers of people are questioning whether accepted practices in modern agriculture and veterinary medicine are devoting adequate attention to the problem of maintaining quality while increasing production. They quote a famous American wildlife manager, Aldo Leopold, who said "Though the Art of Land Doctoring is being practised with vigour, the science of land health is yet to be born." In California citrus orchards, entomologists have found that predatory and parasitic insects do, as a rule, keep pest insects below economically destructive levels, but that these predators are damaged more by spray operations than the pest they were intended to control. Soil health may be similarly affected by our heavy-handed techniques. Ecologist Charles Elton tells us that a lifetime of study has convinced him that the only stable environments are those which contain as diversified a population of plants and animals as nature has learned to produce in that area: that without biotic diversity there appears to be no stability.

Gentlemen, these several threads of biological evidence point up the fact that native bird populations, like the soil, flora and fauna most of us are hardly aware of, have important biological roles to play in keeping our environment productive and attractive. We hear the all-too-common question of the uninformed, "What good is it?" being asked about the birds under study here. The answer, I believe, is neither economic nor esthetic, as many have argued in the past. Instead, the answer is to be found in the biological and ecological values of these species, values of unquestioned significance to all of us. It will, therefore, be a matter of considered policy for the National Audubon Society to oppose any tendency to classify any native birds as pests, and as something to be rid of the way we have tried to get rid of insects. Certainly some birds do pose problems locally and temporarily, but the sensible approach is to control the damage they may do without eliminating or drastically reducing the birds themselves. After all, these birds are of real value to the nation and its people in most areas and most of the time.

At the August hearing in Washington the most outspoken advocate of controlling blackbirds was a corn farmer. After the hearing we had lunch with him and learned that he had solved the blackbird problem on his own farm by switching to a variety of corn with a deep-set ear (Pioneer 302A). When we asked him why such a cultural change wouldn't solve everyone else's problem he said, "Well, you know how independent farmers are. You can't tell them anything."

As you have heard today the most discussed blackbird problem nowadays is in the rice-growing region of Texas, Louisiana, Arkansas and California. Rice-growers have been very outspoken about the need of blackbird control and have already taken things into their own hands in some cases, and have, we are told, resorted to aerial application of TEPP, a very dangerous poison which is not cleared for such use by the Fish and Wildlife Service. When we look into the background of this problem what do we find? A release by the United States Department of Agriculture, dated January 22, 1960, reports that 58% of all milled rice stocks on hand on January 1 of this year were owned by the Federal Government. In other words, it seems to us that the conflict of interest we face is one created by the price support policy of one government department, the United States Department of Agriculture, while another department, Interior, is being asked to eliminate the headaches generated by a policy over which it has no control. This, then, is much more than a bird depredation problem. It is a problem of over-all resource-use policy, and our feeling is that an intelligent solution will require modifying policy all around.

I might be more specific on this point by saying that we are very much concerned to see that most solutions put forth by professional people in agriculture, and even in State and Federal fish and wildlife agencies, are technologically oriented instead of being ecologically oriented. The solution to this problem lies not in finding some new chemical poison to eradicate the things that interfere with the economic interests of a few of us, but rather in adjusting our agricultural practices and policies so as to avoid these conflicts. We have been labeling more and more species as "pests" and placing all the emphasis on trying to get rid of them instead of learning how to protect and perpetuate the diversity of nature that makes for long-run stability and prosperity. This is the particular responsibility of research people and educators at all levels. It will require a reasonable spirit of give and take, just as our New Jersey farmer friend learned to plant the right crop in the right place to avoid bird damage.

We feel strongly that everyone must get behind the current research program of the Fish and Wildlife Service which has been described here today, but also, that agricultural experiment stations must help solve this problem by seeking and urging cultural modifications of the practices that are causing the trouble.

A Fish and Wildlife Service biologist has reported, for example, that the birds in big roosts of blackbirds are often not the ones that do the rice damage. It would be blind, therefore, to advocate or condone roost reduction, both because it would kill birds guilty only of performing an important role in the natural scheme of things, and because it probably would bring no material relief to the complainants. We know, also, that by reducing competition, the decimation of winter populations may actually increase the total production of young during the summer, unless these winter reductions are so drastic as to jeopardize the entire population.

Though I speak out pointedly on some of these things that concern us, please don't take this as an indication of unwillingness to listen to reason. When we know more *real facts* about this new problem, and when more suggestions of a give-and-take nature have been aired, I am confident that we will find a solution all of us can live with.

One final point. The Fish and Wildlife Service, at its August hearing, sounded all of us out on the acceptability of changing their bird control policy to the extent of granting permission to "accidentally kill" protected species while engaging in control operations against such species as starlings and blackbirds, which it is now accepted policy to control when suitable cause is demonstrated. We would oppose such a relaxation of policy simply because it would relieve the Fish and Wildlife Service of the responsibility it must now exercise in prosecuting for unwarranted or careless killing operations. None of us will file complaints if an occasional robin is killed when a blackbird flock is reduced, but we want the law to stand so that heedless killing can be controlled.

This puts the Fish and Wildlife Service in the position of judge and jury, but that is why the Service was organized by Congress. Its responsibility is to protect the public interest in the wildlife resources of these United States.

FEDERAL RESPONSIBILITIES IN BIRD DEPREDATIONS CONTROL

LANSING A. PARKER
Assistant Director, Bureau of Sport Fisheries and Wildlife, Washington, D. C.

The Federal Government's responsibility in the management and protection of birds is based on treaties and acts passed by the Congress. Under the Migratory Bird Treaties with Great Britain and Mexico certain species and groups of birds are recognized as migratory, some of which are considered as game birds, such as waterfowl, rails, doves, woodcock, and snipe. Others are classified as migratory insectivorous and nongame birds. The Treaties provide that there may be a hunting season for a maximum period during certain dates for migratory birds and a continuous closed season on migratory nongame and insectivorous birds. There are also provisions which permit the killing of migratory birds when they become seriously injurious to agricultural or other interests.

Other legislative authority exists for the conduct of research on the ecology, food habits, life histories, and control measures for birds. The Congress in 1885 appropriated $5,000 for "the promotion of economic ornithology or the study of the interrelations of birds and agriculture, and investigation of the food habits and migration of birds in relation to both insects and plants." This was the beginning of the Biological Survey, one of the antecedent agencies of the Bureau of Sport Fisheries and Wildlife. The Fish and Wildlife Coordination Act of 1958, among other functions, specifically provides for assistance to and cooperation with other Federal, State, public, and private agencies and organizations in minimizing damages from overabundant species. The Fish and Wildlife Service Reorganization Act of 1956 reiterates that the primary function of the Bureau of Sport Fisheries and Wildlife is to participate in the conservation and management of the Nation's sport fish and wildlife resources for use and enjoyment by all.

It is generally recognized that one phase of bird management includes actions designed to minimize the effects of flocking, feeding, and other habits which adversely affect the economic, aesthetic, or physical well-being of the people of the country. To aid in defining its policy concerning bird depredations, the Bureau of Sport Fisheries and Wildlife recognizes several phases in this activity.

(1) It is essential to conduct research on the food habits, ecology, life histories and populations of the species causing damage. Methods must be devised to prevent damage by the use of repellents, frighten-

ing devices, habitat alteration, and population reduction. We have been engaged in some of these activities since 1885. Currently, all phases are being given attention, particularly as they affect the blackbirds.

(2) Investigations should be undertaken to determine the extent of reported bird damage and the need for, kind, and the scope of control actions. The Bureau participates in these determinations to the extent of its resources, with particular emphasis when the damage is caused by migratory game species.

(3) The public should be informed of proven control methods and management techniques. The Bureau has distributed and will continue to publish and disseminate the results of its research findings. While we have developed several repellents for frightening birds, we have been able to develop only a few methods of reducing populations of nuisance birds which are specific for the species concerned. However, several very promising techniques are being investigated.

(4) To safely and effectively use control techniques the public must be guided by demonstrations of the proven methods. The Bureau has been quite active in this phase as it concerns waterfowl depredations on farm crops, and will continue to do so within the limits of its resources.

(5) The Bureau recognizes that, under certain circumstances and within its legal authorizations, it will participate in direct population reductions. The conditions under which it engages in nuisance bird reductions are set forth later in this paper.

But first it is desirable to reiterate that we recognize three groups of birds. There are the two which are protected by Federal statutes; namely, migratory game birds, and migratory nongame and insectivorous birds. The third group embraces all of the rest which are not afforded this protection.

Considering first the migratory game species, the Bureau's policies and procedures provide that it will assist in the use of herding and frightening devices; distribute grain to bait the birds from depredation areas; acquire and manage habitat areas to hold the species from private lands; and issue killing permits and/or special orders permitting hunting by the general public.

The Bureau's program relating to abatement of migratory insectivorous and nongame bird depredations provides for the issuance of permits and departmental orders authorizing the killing of depredating species under prescribed conditions. On May 13, 1948, the Secretary of the Interior issued an order relating to the control of blackbirds and grackles (Order No. 2426). Under this authorization any person may kill several listed species of blackbirds and all grackles when they are found committing or about to commit serious depredations upon any agricultural crop or ornamental or shade tree. Other provisions impose certain restrictions on the disposition of the birds, permit Federal inspection of the operation and require conformance with State laws. Thus, under current regulations, there is no Federal prohibition against any individual killing these species to protect his farm crops.

Under certain circumstances the Bureau may act to reduce migratory nongame bird populations after a determination has been made that nonreductional methods are ineffective. These actions are limited to lands and waters under its administrative control, and on public lands and waters under the administrative control of other Federal agencies when they will assume a substantial part of the cost of the control program. Also, the Bureau will participate in reductional programs on non-Federal land or water areas where a protected depredating species is involved if, by provision of cooperative agreements, a State agency or a political subdivision of a State assumes the cosponsorship and substantially contributes to the cost of the control effort. On private lands, the Bureau will provide technical advice and guidance for the control of depredating migratory species, such as the blackbirds, which are excluded from protection by departmental orders or killing permits. However, there must be a cooperative agreement with the State agency or political subdivision of the State which establishes the cooperating agency as the sponsor and its responsibility for the program, including the cost of the control effort. The reason for participation by the Bureau is to assure that protected birds and other wildlife are properly safeguarded. In the event a State agency or private landowner desires to control migratory species excluded by departmental order, the Bureau may, upon investigation of the circumstances and the proposed method of control, issue special permits to cover the accidental and incidental destruction of protected migratory bird species.

The Bureau will engage in the reduction of populations of birds not protected by Federal statutes, such as the starling and English sparrow, in specific instances. Participation is limited to lands and waters under its administrative control, or public lands and waters under the administrative control of other Federal agencies, provided they assume the cost of the control work. On other land and water areas, the Bureau will furnish technical advice and guidance in order to safeguard protected migratory birds and other wildlife. However, there must be a cooperative agreement with a State agency or a political subdivision of a State which stipulates that the cooperating agency will assume sponsorship and cost of the control program. After field investigation and consideration of the proposed control methods, the Bureau may issue killing permits to cover the accidental destruction of protected species resulting from programs of reducing unprotected species.

The bird control program of the Bureau of Sport Fisheries and Wildlife is based on certain premises and guiding principles. It recognizes that the public's regard for birds varies as to time, place, and circumstances; that there is much overlapping in the distribution of locally desirable and undesirable bird species; and that most bird depredations are characteristic of individual species and are local in scope. The guidelines being followed in the Bureau's bird control program are:

(1) Extermination of an indigenous species must not be allowed to occur as a result of the control program.

(2) Control actions must be tempered by aesthetic and recreational, as well as economic considerations.

(3) Control actions must be based on ecology factors that result in the least possible interference with other animal and plant life.

(4) Population reduction methods are not recommended or applied when adequate control can be effected by other means.

(5) We do not recommend or engage in control methods which inadequately safeguard protected birds, other wildlife, persons or their property.

(6) The Bureau does not directly engage in the reduction of migratory game bird populations. Where a local reduction is necessary, it will be accomplished by means of hunting regulations, permit, or special depredation orders.

(7) The Bureau will not recommend or engage in control activities contrary to any State or local law, ordinance or regulation.

(8) We recognize permission to use controls on any land area is the prerogative of the owner, occupant, or administrator of the land involved, except as may be modified by due process of law.

SUMMARY

The Bureau has definite statutory responsibilities for certain birds. It conducts research on methods of alleviating bird damage; publishes findings on recommended methods; demonstrates control techniques; and participates in the dispersal and reduction of bird populations. This participation includes the use of various nonreductional methods for migratory game birds; the issuance of killing permits and general orders to reduce the damage caused by local populations of migratory birds; the issuance of permits to cover protected species accidentally killed as a result of a control program and the actual reduction of nongame birds doing damage under certain conditions.

DISCUSSION

MR. JACK BERRYMAN [Utah State University]: I would like to ask Mr. Buchheister what the position of the Audubon Society is on control of starlings.

MR. BUCHHEISTER: We have no special policy with regard to control of starlings. We look upon the starling as an introduced nongame bird, and we do not feel in any way that when starlings are getting out of hand here and there that local control exercised in the proper way is a bad thing.

We are against massive controls, such as the elimination of an entire roost by toxic chemicals and especially where there can be other birds in the roost, but we have no particular policy with regard to starlings. We have never protested, although we have heard of people who have killed starlings. It is not a protected bird, and it is an introduced species.

MODERATOR GILTZ: It seems relatively simple when we have a group of people here who are primarily biologists. They seem to see this problem from one end to the other even though part of the problem stems from the fact that some do not know the biological aspects as we do. In the way the members of the panel laid down the statements on this program it seems pretty well decided that this is a complex problem. Certainly you have some other detailed questions that we might consider.

DR. J. J. HICKEY [University of Wisconsin, Madison]: I have a question for Dr. Johnson. It would seem that, as the nation becomes increasingly urbanized, we may also expect increasing urbanization of the bird population. As bird density increases, will the threat of encephalitis outbreaks become more serious? Will there be an increase in other arthropod-borne diseases such as psittacosis, pasteurella infections, salmonellosis, avian tuberculosis, fungal diseases, liver flukes, and many external parasites which also can cause dermatitis and discomfort to human beings?

DR. JOHNSON: In the urban areas the common English sparrow seems to be the only source for the virus to turn over, and again I think this is an introduced bird, isn't it? And there is no restriction on destroying the sparrow.

I really feel that it's a bird which you can deal with very much as you deal with bats when you get them in your houses. You just make it impossible for the birds to build nests. That is the best way to discourage them. If bats are coming in, you make bat-proof your dwelling rather than trying to kill them. As far as other diseases are concerned, I purposely restricted this to the arthropod-borne virus diseases, and I see at the present time no problem other than psittacosis, but that is a relatively minor one and I don't think it will increase. The problem there is in viruses introduced by the birds and spread to domesticated poultry.

DR. CARLTON HERMAN [Bureau of Sports Fisheries and Wildlife]: I would like to make a brief statement in regard to one item Dr. Lindzey brought up. That is the possible potential of some day being able to use disease as means of controlling situations such as that in the blackbird. There are many criteria that must be satisfied before any one can tackle such a problem. I would like briefly to mention only two because they are of the most importance before we can go any further.

As Dr. Johnson pointed out in his paper, things that are common in a species are usually of little importance. It's the aberrant parasites or disease-causing agents that would be important in control so that the primary thing that has to be found is a disease that is rare or nonexistent in the blackbird that therefore might be extremely pathogenic.

The other problem is that any disease agent that is used must be highly host specific. We have one classic case as far as vertebrates is concerned, and it has been dramatic, and most of you are aware of it. That is the control of the *Oryctolagus* rock rabbit in Australia and its destruction in European countries.

Here we have an unique situation of viral disease that occurs, in its native habitat, in cottontails in South America. We have an aberrant host which is highly susceptible to infection. In laboratory strains, for example, it runs 100 per cent almost continually, and uniquely the European rabbit is the only one that suffers a fatal infection to this disease-causing organism.

We know at present of no disease-causing organism that is specific in any individual family of birds. We must do a great deal more research before we can possibly delve into this and find something that is most specific. At the present none is available.

MODERATOR GILTZ: It seems as though almost any point that we can mention now has been covered much better than we can by simple statements. I have tried to sum up some points that we have agreed upon if there are no other questions.

Number one. The depredation of crops by birds is a complex ecological problem involving many individuals and agencies which are interested directly or indirectly with methods of controlling the depredating species without conflicting with another individual's interest.

Number two. The most acceptable management of depredatory birds is obtained from those practices that discourage birds from destroying crops and at the same time do not interfere with the benefits derived from their presence.

Three. No single technique of protection from bird depredation may be expected to give uniformly satisfactory results and specific control must be tailored to individual problem situations.

Four. There are numerous bird damage problems for which there are now no known solutions.

Five. Most serious depredations and nuisance problems are concerned with red-winged blackbirds, grackles and starlings.

Six. Most serious agricultural problems are encountered in corn, rice and grain sorghum culture.

Seven. Individuals and groups attempting to solve serious bird damage problems have used techniques of bird population reduction that have not been evaluated as to their potential side effects and effectiveness in resolving the problem.

Eight. The primary research need for developing a satisfactory depredation control program is basic knowledge concerning the biology and ecology of depredating bird species.

Nine. Fundamental data are needed regarding the agronomic practices and crop plant varieties that may be expected to provide important relief from bird depredation.

Number ten. The assistance of agricultural experiment stations is essential to the development of suitable agronomic practices and development of crop variety that will reduce bird losses.

Eleven. State game departments have an important interest in this problem where control measures applied against nuisance birds may affect desirable wildlife, in instances where bird depredations seriously reduce foods available for desirable wildlife species such as waterfowl and from the standpoint of aiding in nuisance animal control to maintain good public relations.

Twelve. Because of the complexity of the problem and many responsibilities involved, solutions can best be developed through joint efforts of state and Federal biologists working in cooperation with agronomists and crop specialists.

I can say no more that would strengthen anything the panel members have said here, but I have a poem that seems to fit into the problm both in our hurrying to get ahead which seems to be part of our problem and also in taking our time which is what we need to do when we develop research methods. The poem by Christopher Morley goes something like this:

He rushed up to St. Peter's gate, and;
  Fearing as usual, that he'd be late,
Jostled a little to get ahead,
  He forgot that he was dead.
"Patience," cried the old man apostle.
"Take your eternity," he said.

TECHNICAL SESSIONS

Monday Afternoon — March 7

Chairman: E. A. Seaman
Advisor on Natural Resources, United States Air Force, Washington, D. C.

Discussion Leader: C. Gordon Fredine
Chief Biologist, National Park Service, Washington, D. C.

WETLANDS AND INLAND WATER RESOURCES

WILD RICE PRODUCTION FROM NEW WETLANDS

Charles H. Stoddard,
Resources for the Future, Inc., Washington, D. C.

Wild rice, which was a staple grain of the Chippewa and Sioux Indian tribes for many centuries, is one of the few small cereal grains found in the world which has not yet been thoroughly domesticated. It appears to be the only small grain in the Western Hemisphere fitting this category. Therefore, recent efforts at cultivation which are of interest to agronomists and pose some challenging problems, also present distinct opportunities to wildlife conservationists. This is particularly so because wild rice *(Zizania aquatica)* requires wetlands in which to grow; and some types of wetlands have been subject to severe drainage programs ever since settlement began.

Although Oliver Hudson Kelley (1853), the founder of the National (Farmers) Grange had proposed cultivation of wild rice in 1853, it was not until 102 years later that the first efforts were begun to grow wild rice as a commercial crop. Although Kelley did not suggest flooding of open swamplands for growing of wild rice, Joseph Bowron of Willow Run, Wisconsin, did at about the same time (Bowron, 1852). While duck hunting clubs have planted wild rice with varying success near their shooting grounds, such plantings have not been evaluated in terms of success or failure, and, in any event, they were not established for commercial harvest. In 1955, the author felt that wild rice might be brought under cultivation. This paper is intended to relate this experience and that of several others who are attempting the same program.

FACTORS AFFECTING GROWTH OF WILD RICE

The natural distribution of wild rice is scattered over a wide range in the eastern United States, but it appears to reach its optimum development in the shallow lakes of northwestern Wisconsin and northern Minnesota. Here, the size of the grain and the density of stands are sufficiently large to warrant economical harvest for human use. The abundance of lakes of glacial origin, especially those with flowing water over shallow silt beds in this region, permit the development of large dense stands with high grain yields. In other parts of the country where varieties of the species are found a much smaller sized grain is characteristic. Moyle estimates that there are about 30,000 acres of high-grade wild rice stands in Minnesota embracing 5 acres or more. Wisconsin probably has only about one fifth of this acreage.

The rice plant is an annual which sprouts from seed late in April at water depths of 1 to 3 feet as an optimum. By late June a ribbon-like leaf begins to float on the surface of the water; shortly thereafter a flowering stalk begins to elongate. The root is very lightly set in the silt bottom so that heavy winds or high water from intense rainfall which raises the water level of the lake may tear loose large numbers of the buoyant-stemmed plants and cause them to float ashore. Toward the end of August, when the grain ripens, the rice "fields" look not unlike a grainfield from a distance — water being completely obscured by the dense stand in rice. The grain ripens unevenly over a period of ten days to two weeks with a few kernels ripening each day and shortly falling off the plant into the water.

Although the sizes of the grain kernels are fairly uniform in individual stands there is considerable variation in size in different lakes. The smallest grains were measured at 8 mm. and the largest at 18 mm. in Minnesota by Moyle. Two principal varieties are found: *Zizania aquatica* and *Zizania aquatica v. angustifolia.* The former appears to be taller with wider leaves and is found in harder waters.

Observation and studies primarily by Minnesota scientists have established that certain basic conditions must be present in order to make wild rice growth possible. Work by Moyle, (1944), Lawrence (1951) and Rogosin (1954) of the Minnesota Wild Rice Committee and summarized by the writer (Stoddard, 1957) sets forth the following physical and chemical conditions which appear to be required in lakes where grain has persisted over many decades if not centuries.

1. Water slowly flowing through rice beds appears to be necessary in most cases, although rice has grown in lakes with neither inlets nor outlets.

2. Water depths between 6 inches and 4½ feet are commonly the range occurring in natural beds.

3. Nearly constant or slightly declining water levels through the growing season are essential, since the buoyant rice stems and leaves will pull the roots out of the loose muck if levels rise.

4. Water with a total alkalinity of 40 to 200 p.p.m. contains the best stands of rice.

5. Soil hydrogen-ion concentration as nearly neutral as possible. (Soils in two rice-lake beds tested by this writer had a pH 5.9 and 6.0, however).

6. Water pH from 6.8 to 8.8 seems to support the best stands.

7. Sulfate-ion concentration below 10.0 p.p.m. is a condition for the best growth, although somewhat more is tolerated where dilution by surface runoff is frequent.

8. Soil-nutrient components were not mentioned in these reports, but the writer's limited tests of wild-rice lake bottoms showed low percentages of available potash and phosphate and high organic content of soil. Responses to fertilizers are untested.

In addition, Moyle (n.d.) has observed some other factors which influence the growth of the crop from germination to ripening of the grain. He notes that weather during pollination may determine the success or failure of the forthcoming yield. The wild rice head is separated into female flowers at the top of the stalk and male flowers on the spreading branches below. For the pollen to get to female flowers at the top takes mild summer winds which will bend the stalk downward and at the same time blow the pollen so that it catches on the flowers. Too dry, hot weather may be an adverse factor in pollen spread as well as summer calms or heavy rain. Pollination extends unevenly over several weeks with a few flowers pollinating at a time, with the result that half-ripened grain and pollinating flowers may be observed on the same stalk. Wild rice is also subject to damage from insects, diseases and predaceous birds. The wild rice worm *(Apamea apamiformis)* has been found to be very destructive to stands in some years by Canadian workers (MacKay and Rockburne, 1958) and the author's own observations. In addition, the common ergot fungus destroys large numbers of plants in some years. To add to the difficulties, redwing blackbirds frequently swarm over the ripening rice stands in a manner similar to that in other grainfields. They have been observed by Dr. Ira Gabrielson pinching the milky kernels with their beaks and eating the contents while at the same time shattering off any ripened grains. Waterfowl, which generally pick up rice from the lake bottoms after it has fallen off the stalk, seldom take enough to reduce stand density in the next crop season. In fact, there is some evidence that waterfowl may be beneficial in years of too dense seed crops.

CULTIVATION OF WILD RICE AS A CROP

Between 1940 and 1958 the price of processed wild rice in the retail market has risen more than 700% while the average of all other commodities has risen approximately 234%. In addition to the general rise in prices during our post-war inflation the cause of this phenomenal rise is due in part to the affluent society in which we live wherein more of the consumer's dollar is available for luxuries. But unlike the economic behavior of most commodities in which the supply would be expanded in response to the higher price level, the supply of wild rice is inelastic and has remained almost constant. The only fluctuations in annual production are due to natural phenomena which affect yields. Therefore, the recent interest on the part of the writer and others in cultivating wild rice as a domestic crop developed from the potential rewards which were theoretically possible from growing the crop on flooded marshlands.

The natural wild rice lakes generally belong to the states in which they are located and are subject to harvest and other regulations. Minnesota regulates the time when the harvest may begin and also excludes the use of machinery on the theory that mechanical harvesting may reduce seed supplies and take away a source of income for local Indian "ricers." Reseeding of the new crop depends heavily upon wasted seeds which fall off the plants during harvest. Therefore, the prospect of being able to grow wild rice on flooded private lands which could be harvested by machinery seemed to offer a profitable opportunity for utilization of lands of relatively low productivity. The northern Lake States contain many thousands of acres of non-forested (but perhaps once forested) marsh lands with small streams moving through them. No actual inventory has been made which separates these from swamps without water movement. As pointed out previously, water is necessary to flood the marsh to the proper depth for wild rice to grow. Also slow movement over the beds or at least a perceptible change of water seems to be essential for the best crop development. These natural swamp areas lie to the north and northeast of the prairie wetlands (also of glacial origin) which have been and are being subjected to intensive drainage for agricultural development. Surrounding lands are not as fertile and often are forest-covered so that the wooded areas of the Lake States have had limited waterfowl breeding and nesting.

The projects which have been undertaken in Wisconsin and Minnesota to date have been principally efforts to dam small streams and to flood open grassy or brushy marshes in such a way as to achieve a replication of natural wild rice lakes. One concern has been attempting to grow it in diked paddies in which the water levels can be closely controlled by pumping and draining during the crop season. Likewise, a more effective use of fertilizers and easier access to the growing grain is probably possible. Added expense in diking and water pumping is a partial offset to this advantage.

Prior to the undertaking of an artificial wild rice lake development careful analysis of soil and water conditions is an essential step if failure is to be avoided. Those conditions which must be satisfied or approximated have been enumerated previously. Soil tests to make certain that acidity is low (pH around 6) and that a good decomposed peat muck overlays sand or clay should precede any actual development. Likewise, it is important that waters are low in alkaline salts. If the water is hard, this may be an actual advantage according to Moyle.

Natural dam sites where necks of land stretch out into the swamps usually provide economical locations for placing in the necessary fill material and construction of the spillway. These procedures are well established by the Soil Conservation Service and State Departments of Conservation and need no elaboration. However, experience appears to indicate that a thorough burning of the marsh where brush and heavy grass are present exposes the soil in such a way that rooting of the seed is made easier. Discing did not seem to accomplish any very significant improvement in site preparation as compared with the stands of rice found on undisced sites.

To the writer's knowledge there are three developments in northwestern Wisconsin and at least three in Minnesota, one of which includes the publicized program referred to previously in which diking and pumping water on fields is being substituted for damming and flooding. All of the efforts have produced wild rice since they were established but with about as erratic success as that experienced in natural lakes. After two successful crop years on one area and a third expected, high water caused by an 8 inch storm in 36 hours which the emergency spillway couldn't handle, lifted the buoyant stems and ruined the crop so badly that it had to be completely replanted.

Yields in most cases, even on successful fields, have been disappointing, not because of poor kernel formation but more usually because of the effect of damage due to one or more of the insects, diseases, predators, or unfavorable weather conditions. Means of controlling the first three are limited or unavailable to wild rice growers nor are resistant varieties obtainable. We are beginning to get some experience on how to repel redwing blackbirds, however. After trying flashy streamers, shooting with a .22 rifle and shotgun blasts, it was found that the new Japanese shotgun shell which lobs out a lighted firecracker into the midst of a flock seems to have enough traumatic effect to force the flock to leave permanently. Moyle feels that biological controls over the wild rice worm through using the same fly which feeds on the forest tent caterpillar has distinct possibilities and should be included in a research project.

Wild rice production on private lands has the advantage of not being subject to state restriction on the use of mechanical harvesting equipment. Several home-made harvesters have been developed which utilize the principle of the reel on a grain harvester powered by a small gasoline motor. The reel is mounted on the bow of a flat bottomed boat and turns slowly as the boat moves forward knocking off the ripened kernels into the squared-ended boat. A small, weedless-propellered outboard motor reduced to trolling speed seems to provide adequate power for forward locomotion. The stalks with unripened grain pass under the boat and emerge unharmed for further ripening. The process is repeated several times at two-day intervals until most of the grain is harvested. The flailing action of the reel tends to knock enough grain into the water to provide seed for another year's crop.

The new crops of wild rice which are developing on these flooded waste lands give much promise for the future. There is no question but what conditions favorable to wild rice growth and comparable to those found in natural lakes can be developed artificially on areas where soil and water conditions are favorable. There are several aspects, however, which are in need of considerable research and experiment if we may expect any large numbers of people to engage in the production of this crop. There are also possibilities for auxiliary products such as fish, furbearers and recreational uses of these newly created waters which offer income possibilities. And there is a significant waterfowl production potential which exists and can be developed with some manipulation of habitat. All of these aspects depend heavily upon the success of the wild rice crop, which must be the primary economic incentive for people to make the capital investment in basic land and water facilities.

RESEARCH NEEDS

To make wild rice production feasible on a large scale will require a major research effort in a number of separate directions. We have enough developed and natural wild rice marshes to permit experimental work in the following types: water level influence on crop yields; influence of liming of waters on growth and yield of plants; experiments in use of fertilizers on plant growth. These types of experiments need also to be pursued under controlled laboratory conditions of the type which Rogosin has carried out in Minnesota. One problem which appears to have developed on the writer's five-year-old marsh is a steady encroachment by submergent weeds to the point where growing space may be adversely affected. We have attempted to kill these weeds by lowering the water level, allowing the ice to freeze them solid, and then raising the water level as the ice begins to melt to pull out the weed growth. The success of the management measure will not be known until late April of this year.

Special studies are also called for in the development of a strain of rice which neither shatters so easily as in the wild nor ripens so unevenly. Both of these characteristics are undesirable in that they make for difficulty and added expense in harvesting and thus increasing production costs. The possibilities of biological control of the wild rice worm has been indicated as needing special experimental study. To date there has been no formal research effort except that by Rogosin at the Wilderness Research Center near Ely, Minnesota, carried on to ascertain the influence of depth on plant development.

Another whole area in need of study is the fish and wildlife production and habitat requirements around the artificially created wild rice lakes. As in other instances, the potential production can be realized only if added measures are taken to provide essential elements for successful survival and increase of each species considered desirable. Muskrats are apt to enter the new lakes without encouragement and will need to be regularly trapped to avoid loss to the crop. Mink and otter will also find their way into these areas, particularly if a balanced fish and aquatic animal population is introduced. Production of forage and bait minnows offer distinct possibility for income in a region known for its vacation lake fishing; and production of game fish both for food and sport would offer additional sources of income.

Research, including direct habitat improvement practices, should begin around the presently developed wild rice marshes to determine what potential they have, not only for furbearer but fish and waterfowl production. Enough information is already available to indicate that grassy borders and islands for nesting, resting and escape will increase waterfowl use. But if we are to get the maximum value out of these newly developed wetlands as an offset to the drained marshes farther to the south and southwest, every effort should be made to find out whether they may be developed so as to provide proper habitat for some of the prairie ducks. Experimental work in New York State with redheads and canvasback has shown that these species will become adapted to new impoundments in habitat not previously considered desirable.

And finally there is a need for the type of research which the farm management people have long carried out on conventional farming operations. Record-keeping of the basic project construction and development costs should form a basis. In addition, however, regular cost and income records should be instituted on a number of wild rice enterprises to give some idea of both the initial cost and the income potential. Related to these should be a complete record-keeping of the management operations involved not only in the actual culture of wild rice (and this is the most important), but also in the production of the auxiliary crops of furbearers, fish and recreational uses. The dovetailing of the managerial duties with these multiple operations calls for a degree of skill which can only be attained through trial and experience at this stage. Future wild rice farmers will be aided greatly in records and information so derived.

CONCLUSION

Accelerated drainage of the remaining Minnesota and Wisconsin prairie marshes has become a vital issue in the conservation movement. The economics of profitable agriculture are driving swamp owners into drainage for crop production—thus converting areas of primary value for water and wildlife conservation into income-producing lands. The public is the loser in the long run, and the private owner the short run gainer. Purchase of some wetlands by public and nonprofit private agencies is helping to stem the tide but fund limitations will prevent the acquisition of any large areas.

Just to the north of the prairie-forest fringe areas are large open swamps—often with flowing streams through them—with poor soils and no agricultural values. Usually these grassy swamplands were covered originally with timber which was logged, followed by fire and beaver flowages. They are of little value to wildlife since no open water is present and cannot be replanted to trees because of prohibitive costs. Yet, by flooding, they can be made into shallow lakes at low cost—providing some financial incentive can be found.

If the profit motive is driving central and southern wetlands of Minnesota and Wisconsin into drainage for crop production, the same incentive can be used to encourage development of wastelands both for wild rice production and conservation of wildlife in the North. Until the present decade, artificial production of wild rice on flooded marsh lands had not been attempted. Since 1955 a half dozen landowners in Wisconsin and Minnesota have created artificial impoundments of streams flowing through open brushy or grassy wetlands and have successfully demonstrated that it is possible to replicate the natural conditions for wild rice growth and that a crop may be produced.

Soil and water tests in a number of these areas, which were once glacial lakebeds, indicate that very comparable conditions for wild rice production exist. Construction of low dams at necks of the swamps to impound flowing waters in shallow lakes creates areas suitable for wild rice production.

High prices for wild rice in recent years and the increasing popular demand for this food are such that an expansion in production should be a profitable undertaking by private individuals and public agencies. Further experimentation and research are needed, however, to assure success before any wide-scale effort should be tried. Limited research to date has shown that soil and water conditions are needed, but more research is needed to prove that wild rice can be grown artificially in profitable quantities. Better plant strains must be developed through genetics to increase yields and obtain more even ripening.

LITERATURE CITED

Bowron, Joseph
1852. Wild rice. Trans. Wisc. State Agr. Society. Dec. pp. 286-288.

Kelley, Oliver H.
1953. Wild rice. Trans. Wisc. State Agr. Society, Dec. pp. 264-266.

Lawrence, D. B.
1951. Wild rice. Minnesota Naturalist, 2(2):24-25.

MacKay, Margaret R. and F. W. Rockburne
1958. Notes on life-history and larval description of *Apamea apiformis* (Guennée), a pest of wild rice (Lepidoptera: Noctuidae). Reprinted from The Canadian Entomologist XC(10): Oct.

Moyle, John B.
1944. Wild rice in Minnesota. Jour. Wildlife Mgt. 8(3):177-184.
n. d. Wild rice—Minnesota's native grain. Mimeo reprint. Minnesota Dept. Conservation.

Rogosin, Alfred
1958. Wild rice growth and production in relation to water level, seeding, density, and fertilizer application in Northern Minnesota. Progress Rept. 8 pp. 6 tables. Mimeo.
1954. An ecological life history of wild rice. Univ. of Minn., reprod. by Minn. Dept. Conservation, Div. Game and Fish, St. Paul. 29 pp. Mimeo.

Stoddard, Charles H.
1957. Utilization of waste swamplands for wild rice production. Land Economics, XXXIII(1):77-80.

DISCUSSION

MR. GEORGE SELKE [Minnesota]: I am very much interested in this paper and its presentation and the projects that are being carried on in Minnesota. However, not much was said in your paper about the migratory waterfowl and the wild rice. Do you know whether wild rice could be made to provide habitat, not only for ducks passing through, but for those that stay on in the summer?

MR. STODDARD: To get a very extensive use of the areas, there has to be a manipulation of the area surrounding the wild rice marshes because, ordinarily, they are pretty well covered with brush and consequently, not of the right type of habitat for nesting ducks. However, by providing other types of feed in the low-water areas, ducks can be induced to increase their use of these areas considerably, and this is apparently the case we have observed in the areas developed. However, much more needs to be done if we are going to get an extensive use by breeding waterfowl.

MR. CAMPBELL [Minnesota]: We have noticed that there seems to be a tendency to drain the areas and harvest them on dry land. Therefore, we have been a little concerned about what the beneficial effects on waterfowl and waterfowl production might be. Undoubtedly we may have a tremendous increase in rice production. However, in connection with the coming trends, do you feel that they are going to drain entirely and harvest on dry land?

MR. STODDARD: Well, the real problem is that the stem of wild rice is frequently 4, 6 and maybe 7 feet tall and it is held in place by the water itself. As soon as you take the water off, you may have a bending. Further, there is another factor, and that is that it falls off the plant as soon as it is ripened. If the water is taken off, you may have just enough movement there so that you lose your rice. However, I presume that it will eventually be possible to develop a stock which will stand up when water is taken off and which you could harvest by machinery. However, the critical thing in so far as waterfowl is concerned, is having nesting and breeding areas. Therefore, if some multiple planning is done, it would seem to me that it would be entirely possible to coordinate the growing of the rice with necessary waterfowl breeding conditions. The water would be drained after the ducks have gotten to the flight stage so they could move on into permanent water areas and perhaps come back into the rice areas after they were harvested to pick up whatever might be left.

WATERFOWL FOODS IN LOUISIANA RICEFIELDS

BOBBY G. HARMON
Louisiana State University, Baton Rouge

CARL H. THOMAS
Soil Conservation Service, Crowley, Louisiana

AND LESLIE GLASGOW
Louisiana State University, Baton Rouge

Each year approximately 4½ million ducks and geese winter in the rice-growing areas of Arkansas, Louisiana, and Texas. The waterfowl habitat in this region includes 3 million acres of riceland, approximately 2½ million acres of marsh in Texas and Louisiana, and considerable acreage of hardwood flats in Arkansas. Although the ricelands are utilized by ducks and geese, few have been developed for waterfowl use. It is believed, however, that they have a high potential for duck management, because the acreage is large, the amount of duck food is great, and because on ricefields water can be easily controlled. On the other hand, the control of water in the marsh is more difficult and costly. But in spite of this handicap some intensive marsh management has been initiated.

The total acreage of rice planted annually is based on an allotment system determined by the Federal Government. Generally speaking a farmer can plant one-third of his riceland each year. Thus, two-thirds of the total area is in pasture, rotation crops, or fallow fields, and one-third is in rice. Nevertheless, with present controls, the rice acreage in Louisiana, Arkansas, and Texas, totaled slightly over one million acres in 1958.

The importance of rice in the diet of Gulf Coast waterfowl has been demonstrated by gizzard or gullet content examination by Martin and Uhler, 1939; Singleton, 1953; Dillon, 1957; Chamberlain, 1957; Kimble and Ensminger, 1959; and Wright, 1959. Few attempts, however, have been made to determine the actual amount of rice and other plant food available to waterfowl in the rice fields. Because rice production occupies such a large acreage in Arkansas, Louisiana, and Texas, and because rice is a choice duck food, it seemed advisable to investigate this source of waterfowl food.

The availability of waterfowl food was studied on the coastal prairie in southwest Louisiana from November 1, 1958, to February 11, 1959. Major objectives were to determine: (1) species of plant seeds available to ducks in ricefields; (2) amounts (dry weight) of each species available in pounds per acre, and (3) seasonal availability of these foods. Green vegetation and roots were not included in the study, although it is recognized that they may be important to waterfowl in ricefields. Animal foods may also be important especially in spring.

DESCRIPTION OF AREA

Rice culture in the South is conducted on large level areas that have medium to heavy soils with the capacity to hold water. Rice is sometimes grown on lighter soils which are underlain by relatively impervious subsoils. The rice growing region is characterized by mild temperatures ranging from 70° to 100°F. during the growing season. The annual rainfall is from 50 to 60 inches. The nine farms that were sampled in the study are located in Vermilion, Acadia, and Calcasieu Parishes, Louisiana. In these parishes the farms average about 187 acres in size.

SAMPLING PROCEDURE

Soil samples were taken in November, December, and February from each of the nine farms. With the use of aerial photographs fields were sketched and divided on grid systems so that sample points were distributed rather uniformly. In each field four or five transects were established on which samples were collected at 200-foot intervals until 20 samples were obtained. The sampling point was determined by the sampler pacing the transect to the approximate sampling point, closing his eyes and throwing a foot-square metal quadrat over his shoulder. The sample was taken where the metal frame landed. One-quarter to one-half inch of topsoil was scooped from within the frame with a small trowel and placed in paper bags. The samples were placed in cold storage at 35°F. until each was washed through a set of four screens to remove the soil. The contents on the screens were dried, then put in a seed blower to separate the light chaff from the heavier seed. The final separation of each kind of seed was done with screens, spatula, and forceps. The seeds were then identified, measured for volume, and weighed.

RESULTS

The seeds of twenty-six plant species were found in the ricefields. In Table 1 the families are ranked in descending order, from the one having the largest quantity of seed to the one having the least. Table 2 shows the minimum, maximum, total, and the average pounds of seed by species per acre from all farms in November, December, and February. The total weight of all seeds found in the ricefields in November amounted to 177 pounds. Cultivated rice was the most abundant waterfowl food, averaging 142 pounds per acre in November. This was 80% of the total weight of all seed on the ground. Good rice crops yield approximately 2900 to 3900 pounds per acre. Thus our findings indicate that about 4% of the rice crop is left on the ground. Wild millets (*Echinochloa* spp.) constituted the second most important duck food in the ricefields with 15 pounds per acre, or slight-

TABLE 1. PLANT SEEDS FOUND IN RICEFIELDS

Scientific Name	Common Name
Gramineae Family	
Oryza sativa	domestic rice
Echinochloa crusgalli	barnyardgrass
E. colonum	junglerice
E. walteri	Walteri millet
Brachiaria platyphylla	Signalgrass
Paspalum plicatulum	brownseed paspalum
Oryza sativa var.	red rice
Paspalum distichum	knotgrass
Cyperaceae Family	
Cyperus albomarginatus	nutgrass
C. virens	nutgrass
C. iria	nutgrass
C. erythrorhizos	nutgrass
Eleocharis quadrangulata	squarestem spikerush
E. obtusa	blunt spikerush
Fimbristylis miliaceae	fimbristylis
Rhynchospora corniculata	horned beakrush
Polygonaceae Family	
Polygonum hydropiperoides	swamp smartweed
Polygonum pennsylvanicum	Pennsylvania smartweed
Leguminoseae Family	
Glottidium versicarium	bagpod
Sesbania macrocarpa	sesbania
Euphorbiaceae Family	
Caperonia castaneaefolia	birdeye
Buettneriaceae Family	
Melochia corchorifolia	teaweed
Rubiaceae Family	
Diodia spp.	poor joe
Nymphaeaceae Family	
Nymphaea spp.	waterlily
Commelinaceae Family	
Commelina spp.	dayflower
Carduaceae Family	
Gymnostyles anthemifolia	unknown

TABLE 2. POUNDS OF SEED PER ACRE FOUND IN RICEFIELDS, NOVEMBER, DECEMBER, FEBRUARY, 1958

Species	November (7 fields)				December (9 fields)				February (9 fields)			
	Min.	Max.	Total	Av.	Min.	Max.	Total	Av.	Min.	Max.	Total	Av.
Oryza sativa	61.8	296.0	996.6	142.4	11.1	171.6	503.3	55.9	.5	24.0	109.6	12.2
O. sativa var.	0	56.7	60.1	8.6	0	25.9	50.8	5.6	0	34.6	38.3	4.2
Echinochloa spp.	2.4	33.7	104.2	14.9	.9	92.8	150.8	16.7	.5	58.8	134.1	15.0
Brachiaria platyphylla	0	12.5	21.3	3.0	0	4.3	5.3	.6	0	7.2	10.5	1.2
Cyperus iria	0	13.9	13.9	1.9	0	16.3	24.0	2.7	0	16.8	16.8	1.9
C. albomarginatus	0	6.7	6.7	.9	0	13.5	14.0	1.5	0	10.1	10.1	1.1
Paspalum plicatulum	5.5	10.1	21.4	3.1	0	4.8	11.5	1.3	1.4	9.6	12.4	1.4
Polygonum hydropiperoides	0	2.8	6.4	.9	0	1.4	1.4	.1	0	2.8	4.7	.5
Caperonia castaneaefolia	0	3.4	4.8	.7	0	1.4	1.4	.1	0	.5	1.0	.1
Eleocharis quadrangulata	0	1.1	1.1	.1	0	2.4	2.4	.3	0	1.9	1.9	.2
Paspalum distichum	..	..	..	..	..	..	..	..	0	.5	.5	.1
Diodia spp.	..	..	..	..	0	1.4	1.4	.1	..	..	..	..
Glottidium versicarium	0	2.4	2.4	.3	..	..	..	..	..	..	..	..
Total				176.8				84.9				37.9

ly over 8% of all seed found. These wild millets are weeds in rice culture and their growth is discouraged. Red rice, also a pest in rice culture, ranked third in abundance in November at 9 pounds per acre.

Brownseed paspalum and signalgrass constituted only a minor part of the total amount of seeds found in the November samples. These seeds have been rated high as duck foods in the rice area (Dillon, 1957), but since they are normally limited to field borders and levees in harvested fields, the amount found was small. They are more abundant in fallow rice lands. Due to the meager quantity available, these and the remainder of the plant species identified in the samples were considered unimportant as duck foods in the ricefields.

Based on quantity found, the seeds of rice, wild millet (*echniochloa* spp.), and red rice were the only ones abundant enough to be of significant value to ducks in the ricefields. As shown in Table 3, a large decrease occurred in the seasonal amount of rice; a smaller decrease occurred in the amount of red rice; and no decrease occurred in the amount of wild millet.

The average amount of rice per acre for all farms sampled in November was 142 pounds. In December the average was 56 pounds or a decrease of 61%. The average amount of rice per acre collected in February was 72 pounds or a decrease of 92% from November 1 to February 16 (Table 3). There are no data to show the direct cause of the loss in rice as the season progressed, but it is believed that it was due to the following:

(1) Much of the waste rice sprouted after harvest.

(2) Mild weather and periodic alternate wet and dry periods probably caused rice to decompose in the field.

(3) Observations made during the study indicated that 25 to 500 redwing blackbirds, cowbirds, and bronzed grackles were feeding on each farm at one time or another. Just how much food they utilized is unknown, but according to Neff and Meanley (1957), late October flocks of these birds spend most of their time in stubble fields gleaning waste rice and weed seed. They reported that rice comprised 45.4% of the food of 986 birds whose stomachs were examined; the monthly averages were 77.7% in November, 60.7% in December, and 60.2% in January.

TABLE 3. SEASONAL CHANGE IN QUANTITY OF SEEDS IN RICEFIELDS

	Nov. Average Pounds/Acre	Dec. Average Pounds/Acre	Percent Change Nov. to Dec.	Feb. Average Pounds/Acre	Percent Change Nov. to Feb.
Rice	142	56	—61°	12	—92
Millet	15	17	+13	15	0
Red Rice	9	6	—33	4	—55
All Seed	176.8	84.9	—52	37.9	—88

(4) Small mammals such as mice, muskrats, nutria, and rabbits probably ate rice and thereby reduced the amount available for waterfowl.

(5) There is reason to believe that overgrazing of cattle in rice stubble fields decreased the amount of waste rice since they probably ate that which had fallen in the straw.

(6) Farmers and biologists reported that ducks utilized the ricefields very little in the winter of 1958, but geese were frequently observed in them.

The average amount of wild millet per acre for all farms sampled in November was 15 pounds; in December 17 pounds; and in February 15 pounds. There was an increase from November to December (mid season) of 13% and no change from November to February (end of season). While there was no seasonal change from November to February there was an insignificant increase in the amount between November and December. Sampling error may have influenced these figures. It seems that the wild millet seeds should have shown a steady decrease over the collection period, since it is reported that some birds feed on the seed and that seed deterioration is high. Neff and Meanley (1957) reported that 10.8% of the annual food of blackbirds was wild millet. Japanese millet, a variety of *Echinochloa crusgalli,* has been shown to have a deterioration rate of 57% in 90 days under water (Neely, 1956). Nevertheless, the wild millets appear to deteriorate less than rice.

Red rice was the third most abundant seed found in the ricefields. In November the average amount of red rice per acre was 9 pounds. The averages for December and February were 6 and 4 pounds respectively. This was a 33% decrease from November to December and a 55% decrease from November to February. Red rice is commonly thought of as being a seed with a low deterioration rate since it volunteers so readily if not controlled.

The total decrease in all seeds from November to February was 76%. Excluding one minor seed found in the November samples but absent in the other collections, rice showed the highest percent of decrease.

MANAGEMENT DISCUSSION OF RICEFIELDS FOR DUCKS

Flooding of Ricefields

Ricefields that are managed for ducks should be flooded. Some fields should be flooded as early as October to provide feeding areas for the first flights of ducks which arrive. Perhaps earlier and continuous flooding would prevent part of the loss of rice since in this study there was a rapid deterioration of unflooded rice. According to

Neely (1956), domestic rice grains submerged in water showed only a 19% loss in 90 days. This is much less than the rate of decrease encountered with the unflooded rice in this study.

Water should be held on the fields until the ducks leave the wintering ground in late March. The portion of the field with the highest elevation should have at least 1 inch of water while the lowest portion should not have over 12-15 inches. This usually requires some inner ricefield levees in the larger fields. Winter ricefield flooding interferes with cattle operations since cattle are turned into most fields immediately following harvest. Few of the southwest Louisiana rice farmers appear to be willing to give up a large portion of this cattle grazing acreage; therefore ricefield duck hunting would have to be profitable to them in order to obtain proper management. Quite a few rice farmers in southwest Louisiana are avid duck hunters, but their usual practice is to flood a small portion of a field, maybe three or four acres, and hunt it regularly.

Regulation of Hunting and Establishment of Feeding and Resting Areas

Wintering waterfowl habitat should contain resting and feeding areas. Under the present system most ducks feed in ricefields when human activity is at a minimum. That is, in the very early morning and twilight periods and at night. At the least disturbance after daylight, the ducks leave the fields and return to the marsh to spend the day. Cover which would shield ducks in the open fields is almost nonexistent.

Rice areas managed for ducks should contain blocks of land which would serve as feeding and resting sites on which no shooting is done, plus other areas where regulated shooting is practiced once a week. Since some rice farms are not of sufficient size to provide all these requirements, farmer-to-farmer cooperation in management should be encouraged. Under this system the farmers could rotate the responsibility of providing the unhunted areas especially when under a hunting lease. In this way the ducks, farmers, and hunters would profit.

Production and Management of Supplemental Foods

Field studies made by Soil Conservation Service biologists in the Southeast (Davison and Neely, 1959; Wright, 1959) have shown that browntop millet is a choice duck food and will produce around 1200-1500 pounds of seed to the acre. By planting several acres of browntop millet in conjunction with flooded ricefields the quantity of food for ducks would be greatly increased. Furthermore, dollar for dollar and seed for seed, browntop millet fields produce a cheaper duck food than flooded rice stubble fields. For example, 20 acres of browntop millet at 1200 pounds per acre produce 24,000 pounds of seed. It costs approximately 10 dollars per acre to plant and fertilize browntop millet and an additional 3 dollars per acre for flooding. Thus, it costs 260 dollars for growing and flooding 24,000 pounds of duck food. At 177 pounds of seed per acre (the total figure in this study, Table 2), it would take 136 acres of rice stubble to produce 24,000 pounds of seed. Counting flooding cost only, $3 dollars per acre, it would cost approximately 408 dollars to flood 136 acres of rice stubble.

Both fields have their advantages, thus the suggestion for the combination. The larger rice acreage may make an attractive area for ducks, but the planted fields produce more food per acre at a more economical cost.

Land Leveling Practices

The leveling of land in the rice area benefits the rice farmer by providing a better drainage system and more even distribution of irrigation water. These two benefits to the farmer also make the fields easier to manage for ducks. By providing better drainage the soil in the ricefield is drier during harvesting thus preventing the rice harvesting equipment from cutting the field up with deep ruts. A level field enables the operator to flood the rice stubble with a minimum amount of water, thereby reducing the cost of flooding for waterfowl.

SUMMARY

The availability of waterfowl food was studied on the coastal prairie in southwest Louisiana from November 1, 1958 to February 11, 1959. This is an important rice growing area and furnishes food for wintering waterfowl that feed on waste rice and weed seeds in harvested fields.

The objectives were to determine (1) the species of plant seeds available to waterfowl in ricefields, (2) amounts (dry weight) of each species available in pounds per acre, and (3) seasonal availability of these foods.

The total seeds found in ricefields in November samples amounted to 177 pounds/acre. Rice was the most abundant food for waterfowl. It was most abundant in total dry weight and in total volume. The average amount of rice per acre ranged from 142 pounds in November to 12 pounds in February.

The second most important food in the ricefields was wild millet. Red rice, brownseed paspalum, and signalgrass are good duck foods, but were present in small quantities.

Plants of Cyperaceae, Polygonaceae, and Leguminoseae families made up only trace amounts in the total food available for waterfowl in the ricefields during this study and are considered unimportant as food due to the meager quantity found.

A wide variation existed in the seasonal availability of food for waterfowl. The total amount of rice decreased from November throughout February by 92%.

Management measures suggested for the area are:

(1) Ricefield flooding.
(2) Regulation of hunting and establishment of feeding and resting areas for ducks.
(3) Production and management of supplemental foods.
(4) Land leveling practices.

LITERATURE CITED

Chamberlain, J. L.
1957. Gulf Coast marsh vegetation as food of wintering waterfowl. J. Wildl. Mgmt. 23(1):97-102.

Davison, V. E. and W. W. Neely
1959. Managing farm fields, wetlands, and waters for wild ducks in the South. USDA Farmers' Bulletin No. 2144, Supt. Documents, Washington, D. C.

Dillon, O. W., Jr.
1957. Food habits of wild ducks in the rice-marsh transition area of Louisiana. Trans. of the S. E. Game Conf. pp. 114-119.

Kimble, Robert and Allen Ensminger
1959. Duck food habits in southwestern Louisiana marshes following a hurricane. J. Wildl. Mgmt. 23(4):453-455.

Martin, A. C. and F. M. Uhler
1959. Food of game ducks in the United States and Canada. U. S. Dept. of Agric., Tech. Bul. 634. 156 pp.

Neely, W. W.
1956. How long do duck foods last underwater? Trans. 21st N. Am. Wildl. Conf. 191-198.

Neff, J. A. and Brooke Meanley
1957. Blackbirds and the Arkansas rice crop. Agric. Exp. Sta., Univ. of Ark. and Fish and Wildl. Service, U.S.D.I. Bul. 584. 89 pp.

Singleton, J. R.
1953. Texas coastal waterfowl survey. Texas Game and Fish Comm., F. A. Report Series No. 11. 128 pp.

Wright, T. W.
1959. Winter foods of mallards in Arkansas. Proc. 13th Annual Conf., S.E. Assoc. Game and Fish Commissioners, Baltimore, Maryland, Oct. 26-27, 1959. (In press)

DISCUSSION

MR. FREDINE: I cannot help but follow his arithmetic. One hundred seventy-seven pounds of seed in these ricefields at a million acres—that is 177 million pounds of potential duck food. That is not chicken feed.

MR. DILLON [New York]: I would like to point out also that these fields, after the hunting season is over, continue to be flooded and are very important quartering grounds for ducks, and I think that one of the most important things coming out of this work is that we are having a much better quartering area in the spring following the hunting season. I have also found that red rice is tough to work with and yet does not produce a lot of duck food either. Would you recommend, for example, that you plant red rice for ducks simply because it deteriorates less quickly?

MR. HARMON: No, because most of the land is going back into rice production. It is a plant that the farmers themselves will not tolerate if they can possibly help it. I know the attitude of those people about red rice. Of course, this has possibilities, if the crop was planted for ducks, but it would be much harder to get seed than I imagine the rice would be.

LEAD POISONING AMONG DUCKS WINTERING ON THE LOWER DETROIT RIVER[1]

GEORGE S. HUNT[2]
The University of Michigan, Ann Arbor

The lower Detroit River and adjacent marshes (Fig. 1) apparently have been an important stop-over for migrating waterfowl for centuries. The first accounts of the many ducks using this area were written by Cadillac (Burton, 1922:485), French founder of Detroit, in 1701.

It was not until about 1930 that large numbers of ducks commenced wintering consistently in the area. Information from the unpublished journals of Bradshaw H. Swales (records extending from 1893 to 1917), from Barrows (1912), Bent (1923), Wilson (1922), Wood (1951), and from interviews with Messrs. P. H. Dahlka and William Munro, Sr., long-time residents of Gibraltar, Michigan, substantiate the foregoing statement. Burton (1922:1525), Swales' journals, a personal communication from Mr. Ernest Stanton (long-time resident of Grosse Ile), and Messrs. Dahlka and Munro all mentioned that prior to 1930 ice generally covered the entire lower river from mid-December to mid-March. Beginning about 1930, due to increasing volumes of warm industrial effluents and to some extent moderating climate, the west side of the river from Detroit to south of Grosse Ile has remained free of ice. Lately, with large areas of open water to serve as an attraction, many thousands of ducks have spent the winters here (Stewart, *et al.*, 1958:338; Hunt, 1957:87).

During January and February of 1948, an estimated 10,000 ducks died in the vicinity of Grosse Ile due to various causes (Miller and Whitlock, 1948:15). Further losses occurred subsequent to that winter. An existing Federal Aid in Wildlife Restoration duck banding project was expanded to include a study of lead poisoning in the ducks present, as well as, other facets of the waterfowl and habitat complex of the area.

Lead poisoning data were gathered from early 1948 to the early spring of 1955. A total of 14,391 ducks was examined for the presence of ingested lead shot. Fluoroscopy was generally used to deter-

[1]A joint contribution by Federal Aid in Wildlife Restoration project W-45-R, Game Division, Michigan Department of Conservation and School of Natural Resources, The University of Michigan.

[2]I wish to acknowledge the generous guidance provided by Messrs. H. D. Ruhl and H. J. Miller and Dr. S. C. Whitlock of Michigan's Game Division, and Dr. W. W. Chase, chairman of my doctoral committee, and the other members of the doctoral committee from The University of Michigan. Special thanks are extended to Dr. Dale Fay and Messrs. L. B. Pospichal, H. E. Ewing, R. D. Benson, and K. J. Dahlka, at present or formerly with Michigan's Game Division, for their considerable assistance and contributions to this study.

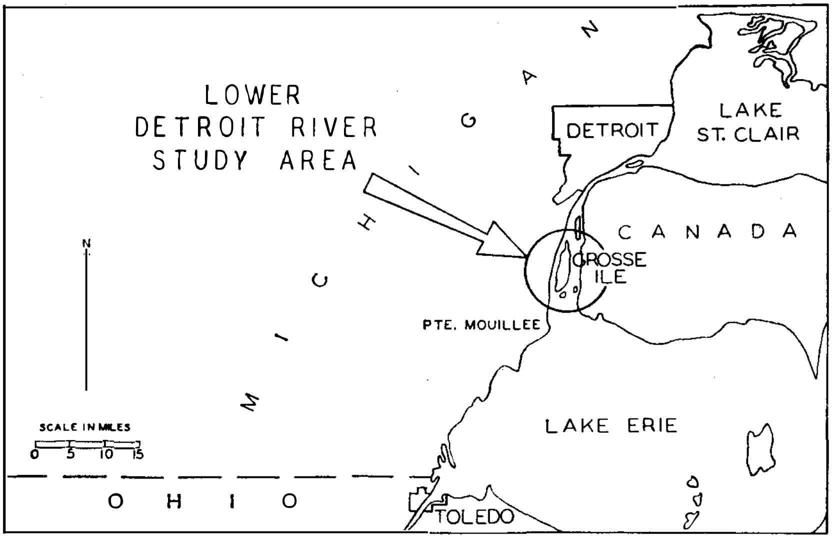

Figure 1

mine whether ingested lead was present in ducks; a few ducks were autopsied instead of fluoroscoped.

This paper presents the results of the lead poisoning study conducted on four duck species: black duck (*Anas rubripes* Brewster), canvasback (*Aythya valisineria* [Wilson]), lesser scaup (*Aythya affinis* [Eyton]), and redhead (*Aythya americana* [Eyton]) (duck names: A.O.U. checklist, 1957). Other species were examined but the information is limited in quantity and is insufficient to warrant reporting.

REVIEW OF LITERATURE

Bellrose (1959:282) states that about 4 per cent of the mallard population of the Mississippi Flyway succumb to lead poisoning each year. He also records a compilation of information from many sections of North America showing an average incidence of ingested shot of 6.66 per cent in 35,411 ducks of 17 species. Morgan (1944:33) cites that 8.6 per cent of 3,000 birds (mainly waterfowl) examined in the West had died from the effects of ingested lead. O'Roke states (in Pirnie, 1935:76) that in his opinion lead poisoning is the greatest cause of death, of a disease nature, among adult waterfowl in the Great Lakes Region. To clarify, I have used "disease" in this article as defined in Hambidge (1942:117): "Any abnormal condition of the tissues of the body."

In contrast to the foregoing summary of information regarding the seriousness of lead poisoning among ducks, Jordan and Bellrose (1951:12), Low (1940:59), Miller and Whitlock (1948:11), Musgrove and Musgrove (1947:108), Toner (1940:104-105), and Wetmore (1919:2) state their opinions that this disease has caused relatively minor losses. On the West Coast, Yocom (1951:131) found a 3 per cent incidence of ingested lead shot in 461 waterfowl examined in a three-year period. This would seem to be an incidence of little importance to the health of a waterfowl population.

Adler (1942:6) and Musgrove and Musgrove (1947:108) expressed concern about the effects of lead poisoning on the fertility of waterfowl. Cheatum and Benson (1945:29) and Elder (1954:322) tested the hypothesis that lead poisoning might reduce waterfowl fertility and found no significant direct or residual effect on the fertility of mallards.

Green and Dowdell (1936:488) felt they had reached a possible solution to lead poisoning by development of a magnesium-lead alloy shot which would disintegrate rapidly in the presence of moisture and, thus, prove non-toxic or unavailable to waterfowl. The research of Jordan and Bellrose (1950:162-165) proved that the several alloys tested are as toxic as regular commercial-type pellets. However, iron shot was non-toxic and Bellrose (1959:286) states his belief that iron pellets provide a possible means of overcoming lead poisoning losses should such mortality reach a serious magnitude in the future.

METHODS

We used a model F-3 portable General Electric X-ray unit fitted with a fluoroscopic screen to determine the presence of ingested lead shot in both living and dead ducks. Settings of 2 kilovolts and 3 to 4 milliamperes provided ample contrast to see lead shot, which appeared as small, black spheres. We counted and recorded the shot as present in body tissues or gizzard (only those with shot in the gizzard are considered in this report). Ducks were inserted individually into a wooden "drawer" which was then moved into position between the X-ray unit and fluoroscopic screen for viewing. Sheet lead with overlapping joints shielded operators from X-rays.

Ducks were live-trapped as described by Hunt and Dahlka (1953). Trapping generally extended from mid-December to late-April each year of the study. Weights of all specimens were secured using a household-type scale with a metal cone soldered to the weighing surface. The ducks were thrust into the cone and the weight recorded to the nearest ounce. Species, sex, and age were determined with the aid of Kortright's (1943) book. Plumage characteristics were relied on in most instances; in some cases the cloacal and bursal methods were employed. Birds were banded with U. S. Fish and Wildlife Service bands. All ducks in good condition were released after data were recorded. Reference to original banding notes when ducks were later recovered made possible an analysis by the author regarding longevity of ducks carrying ingested lead shot as compared to those free of shot.

The biologists engaged on the project also secured specimens from hunters in the study area and by finding dead ducks. These ducks were "processed" in a manner similar to live ones.

RESULTS

Our research conducted in the Detroit River study area was concerned primarily with the incidence of lead shot in the digestive tracts of *wintering* ducks, both living and dead. Table 1 presents a summary of the fluoroscopic findings for living ducks.

TABLE 1. SUMMARY OF INGESTED LEAD SHOT DATA COLLECTED FEBRUARY 26, 1949, THROUGH APRIL 27, 1954, FROM LIVING DUCKS ON LOWER DETROIT RIVER[1]

Species	Number Fluoroscoped	Number with Ingested Shot	Percent with Ingested Shot
Black Duck	2,007	117	5.8
Canvasback	1,473	51	3.5
Lesser Scaup	6,291	149	2.4
Redhead	673	18	2.7
TOTALS	10,444	335	3.2

[1]Includes ducks handled only once and first handling of repeats and returns.

For comparative purposes, a considerable number of ducks found dead in the study area were fluoroscoped to determine whether ingested lead shot was present (Table 2).

Further information was gathered at Pte. Mouillee State Game Area (four miles south of Grosse Ile) during a number of fall hunting seasons (Table 3). Of course, some of the shot found in gizzards was fired into the organ, not ingested. We don't know how often this may occur.

TABLE 2. SUMMARY OF INGESTED LEAD SHOT DATA FOR THE PERIOD FEBRUARY 25, 1950, THROUGH MARCH 6, 1955, FROM DUCKS FOUND DEAD ON LOWER DETROIT RIVER[1]

Species	Number Fluoroscoped	Number with Ingested Shot	Percent with Ingested Shot
Canvasback	507	14	2.8
Lesser Scaup	685	24	3.5
TOTALS	1,192	38	3.2

[1]Only the canvasback and lesser scaup data are given since the black duck and redhead suffered so little mortality during the period of study that similar information for them is nearly non-existent.

TABLE 3. SUMMARY OF INGESTED LEAD SHOT DATA FOR THE PERIOD OCTOBER, 1948, THROUGH DECEMBER 1954, FROM DUCKS SHOT IN PTE. MOUILLEE STATE GAME AREA

Species	Number Fluoroscoped	Number with Ingested Shot	Percent with Ingested Shot
Black Duck	1,533	73	4.8
Canvasback	368	11	3.0
Lesser Scaup	437	21	4.8
Redhead	306	16	5.2
TOTALS	2,644	121	4.6

Dr. Dale Fay, pathologist for the Game Division, Michigan Department of Conservation, made available records of autopsies performed on ducks which had died in the area during the study period. The lead shot portion of the information is in Table 4.

TABLE 4. SUMMARY OF INGESTED LEAD SHOT DATA FROM AUTOPSY RECORDS FOR THE PERIOD JANUARY, 1948, THROUGH MARCH, 1955, FROM DUCKS FOUND DEAD ON LOWER DETROIT RIVER

Species	Number Examined	Number with Ingested Shot	Percent with Ingested Shot
Canvasback	76	1	1.3
Lesser Scaup	35	2	5.7
TOTALS	111	3[1]	2.7

[1]The death of only one duck with ingested shot was definitely attributed to lead poisoning.

The data gathered were analyzed to determine the frequency-occurrence of ingested lead shot in live-trapped ducks in the study area. This information is presented in Table 5.

TABLE 5. SUMMARY OF FREQUENCY-OCCURRENCE OF INGESTED LEAD SHOT FOR PERIOD FEBRUARY 26, 1949, THROUGH APRIL 27, 1954, FOR DUCKS LIVE-TRAPPED ON LOWER DETROIT RIVER

Species	Number Fluoro-scoped	Percent With Ingested Shot				Total Percent With Ingested Shot
		1 Shot	2 Shot	3 Shot	>3 Shot	
Black Duck	2,007	4.9	0.5	0.2	0.2	5.8
Canvasback	1,473	3.1	0.2	0.0	0.2	3.5
Lesser Scaup	6,291	2.0	0.2	0.1	0.1	2.4
Redhead	673	2.2	0.5	0.0	0.0	2.7
TOTALS	10,444	2.7	0.3	0.1	0.1	3.2

Since drastic reduction in body weight is an important symptom in lead-poisoned ducks, weights of ducks with ingested shot were compared to those of "normal" ducks. Table 6 contains these data.

By banding ducks, we secured information in respect to longevity in relation to ingested lead shot. Longevity as used here means: the length of time a duck lived after being banded until recovered dead or alive. During the study 50 of the ducks which contained ingested shot at the time of banding were recovered. Their average longevity

TABLE 6. SUMMARY OF BODY WEIGHT DATA FROM LIVING DUCKS WITH INGESTED LEAD SHOT AND THOSE FREE OF INGESTED SHOT FOR PERIOD FEBRUARY 26, 1949, THROUGH APRIL 27, 1954, LOWER DETROIT RIVER

		Those with Ingested Shot			Those Free of Ingested Shot		
		Average Weight		Number	Average Weight		Number
Species	Sex	pounds	ounces	Weighed	pounds	ounces	Weighed
Black Duck	Male	2	15.4	89	3	0.0	1435
	Female	2	9.7	28	2	9.6	455
Canvasback	Male	2	10.2	38	2	9.7	1073
	Female	2	6.6	13	2	7.1	349
Lesser Scaup	Male	1	9.9	114	1	10.1	4335
	Female	1	9.5	35	1	8.0	1807
Redhead	Male	2	4.9	11	2	5.7	438
	Female	2	1.1	7	2	1.6	217

was calculated to be 1.42 years. For the same period, 998 ducks were recovered which, at the time of banding, were free of gizzard shot, as well as other factors which might reduce life expectancy. Their longevity also averaged 1.42 years. Addy (in Bellrose and Chase, 1950:17), using data from three different banding stations in Massachusetts, found that the black duck in New England lived an average 1.17, 1.29, and 1.49 years. In Illinois, Bellrose and Chase (1950:17) found that male mallards live an average 1.56 years and female mallards an average 1.38 years. I determined by calculations from Table 3 in Geis (1959:255) that the canvasback in North America lives an average 1.50 years. These publications did not differentiate between ducks which were carrying ingested shot and those which were not. The only species comparable to the three mentioned above, for which information is available from the Detroit River, are the black duck and canvasback.

DISCUSSION

The data collected in the study area indicate that lead poisoning is a minor cause of mortality. A 3.2 per cent incidence of ingested shot occurred in the living ducks fluoroscoped and in the ducks found dead and fluoroscoped. Of the ducks shot during hunting season and examined by fluoroscope, 4.6 per cent contained ingested shot (the higher figure being, at least in part, due to shot lodged in the gizzard as a result of gunfire).

Jordan and Bellrose (1951:7) point out that 22 per cent of their experimental mallards which died from being fed lead shot had voided the pellets before death. If the percentages secured by our investigations on the Detroit River are increased by 22 per cent, the incidences still range only from 3.5 to 5.9 per cent, which is below, or just reach, the percentages cited in the literature.

Another determination which we made from the Detroit River studies was that 84.4 per cent of the ducks with lead shot in the gizzard had only one such pellet. Ducks containing only one shot reportedly have a relatively high survival rate. In general, experimentation regarding lethal quantities of lead has indicated that the more lead ingested, the higher the death rate. Wetmore (1919:7) and Coburn, *et al.,* (1951:191-192) conducted such laboratory tests. Cheatum and Benson (1945:26) found that male mallards dosed with one number 4 shot every three to four weeks usually survived. Reid's (1948:125) field data include 218 specimens of the four duck species studied on the lower Detroit River and show a 9.7 per cent incidence of ingested lead shot. Significantly, 62 per cent of those containing lead shot in the alimentary tract had only one shot present. Both Bellrose (1959:260) and Jordan and Bellrose (1951:15-16) have published similar information. Data for the black ducks, canvasbacks, scaups, and redheads in Bellrose's 1959 article show the following: 4,905 examined, of which 10.7 per cent contained ingested lead shot. But, the majority (nearly 67 per cent) of the ducks had ingested only one lead shot, which, as Bellrose points out, would permit a relatively good chance of survival. During the course of his investigations, Bellrose (1959:274) determined by band recoveries from live-trapped wild mallards that those dosed with one shot before release showed a greater loss over a year's time than birds which were not dosed before release. Those dosed with more than one shot suffered greater losses than either control or one shot groups.

The comparative average weights in Table 6 do not indicate, even remotely, the drastic reductions associated with severe lead poisoning. Many publications describe fully, or in part, the abnormalities induced by ingested lead (Adler, 1942:6-7; Biester and Schwarte, 1948:994; Coburn, *et al.,* 1951:190-191; Jordan and Bellrose 1950:159 and 1951:5-8; Musgrove and Musgrove, 1947:107; Nord, 1941:175; and Wetmore, 1919:3-6). They agree there is a considerable loss in body weight with attendant emaciation, particularly of the breast muscles, and lack of fat deposits.

Wetmore (1919:5), and others (probably referring to Wetmore's pioneer investigations), state that the appetite remains normal, or nearly so. Jordan and Bellrose (1951:5) have shown conclusively that food intake is usually lowered by the effects of lead poisoning.

As a part of their research, Jordan and Bellrose (1951:22) discovered that mallards containing no ingested lead shot and deliberately held to the same food intake as mallards dosed with one number 6 lead shot, developed the same symptoms and internal changes and suffered the same mortality as the lead-dosed ones. This experiment clearly indicated that starvation is the direct cause of death, at least at the one-shot level. Nord (1941:175) had earlier reached this same conclusion by observation.

A food habits study on ducks from the Detroit River (Hunt, 1957: 90-91, 266-271) showed that their winter food is mostly the soft parts of vegetation. Such a diet should markedly reduce the effects of ingested shot and, in addition to just maintaining weight, may well have an important role in preventing serious mortality from lead poisoning. Jordan and Bellrose (1951:18) established that a soft diet was more conducive to survival of lead-sickened ducks than either small or large seeds. Elder (1954:322) also determined that variations in resistance by waterfowl to certain quantities of ingested lead were related to diet.

Average longevity was the same for ducks containing lead shot as for those free of it. The average longevity of Detroit River ducks, both leaded and lead-free, differs little from the average life expectancy determined by other biologists in regions quite removed from the Detroit River. Clearly, lead poisoning is of minor importance as a cause of mortality among ducks wintering on the Detroit River.

I want to add that this report covers only a local situation and is not to be construed as discouraging a solution to the general problem of lead poisoning losses. On the contrary, I believe every effort should be made to reduce such losses, especially in view of present low duck numbers and the likelihood of increasing demands upon this resource in the future.

SUMMARY

Beginning about 1930, large numbers of ducks have wintered on the Detroit River and considerable losses have occurred among them from time to time. Our study, extending from 1948 to 1955, determined that lead poisoning is a minor cause of mortality.

The black duck, canvasback, lesser scaup, and redhead were most intensively studied. A total of 14,391 ducks of these four species was examined for ingested lead shot. The incidence of ingested lead shot differed little between ducks which were live-trapped, others which were found dead, others which were shot and examined at a checking station, and still others which were autopsied rather than fluoroscoped. Ingested lead shot frequency-occurrence data for live-trapped ducks are presented. A comparison of weights of living ducks containing ingested shot and of those not containing ingested shot shows little weight difference. The longevity of ducks containing shot was the same as for those free of ingested shot.

LITERATURE CITED

Alder, Frederick E. W.
1942. The problem of lead poisoning in waterfowl. Wis. Cons. Bull., 7(9):5-7.
American Ornithologists' Union
1957. Check-list of North American birds. 5th ed. Baltimore: Lord Baltimore Press. xiii + 691 pp.

Barrows, Walter Bradford
1912. Michigan bird life. Lansing: Mich. Agric. Coll., Special Bull. xiv + 822 pp.
Bellrose, Frank C.
1959. Lead poisoning as a mortaity factor in waterfowl populations. Ill. Nat. Hist. Surv. Bull., 27(3):235-288.
Bellrose, Frank C., and Elizabeth Brown Chase
1950. Population losses in mallard, black duck, and blue-winged teal. Urbana: Ill. Nat. Hist. Surv., Biol. Notes 22. 27 pp.
Bent, Arthur C.
1923. Life histories of North American wild fowl. Washington: Govt. Print. Off., U. S. Nat'l. Mus., Bull. 126. ix + 250 pp.
Biester, H. E. and L. H. Schwarte
1948. Diseases of poultry. 2nd ed. Ames: Iowa State Coll. Press. xiii + 1154 pp.
Burton, Clarence M.
1922. The city of Detroit, Michigan, 1701-1922. Detroit: S. J. Clarke Publ. Co. xxvi + 1608 pp., (Vols. 1-2).
Cheatum, E. L. and Dirck Benson
1945. Effects of lead poisoning on reproduction of mallard drakes. J. Wildl. Mgmt.. 9(1):26-29.
Coburn, Don R., David W. Metzler, and Ray Treichler
1951. A study of absorption and retention of lead in wild waterfowl in relation to clinical evidence of lead poisoning. J. Wildl. Mgmt., 15(2):186-192.
Elder, William H.
1954. Lead poisoning and fertility in mallards. J. Wildl. Mgmt., 18(3):315-323.
Geis, Aelred D.
1959. Annual and shooting mortality estimates for the canvasback. J. Wildl. Mgmt., 23(3):253-261.
Green, R. G. and R. L. Dowdell
1936. The prevention of lead poisoning in waterfowl by the use of disintegrable lead shot. Trans. N. Amer. Wildl. Conf., 1:486-490.
Hambidge, Gove. (Editor)
1942. Keeping livestock healthy. Yrbk. of Agric. Washington: Govt. Print. Off. xiii + 1276 pp.
Hunt, George S.
1957. Causes of mortality among ducks wintering on the lower Detroit River. Ann Arbor: Univ. Mich. Ph.D. thesis. x + 296 pp.
Hunt, George S. and Kenneth J. Dahlka.
1953. Live trapping of diving ducks. J. Wildl. Mgmt., 17(1):92-95.
Jordan, James S. and Frank C. Bellrose
1950. Shot alloys and lead poisoning in waterfowl. Trans. N. Amer. Wildl. Conf., 15:155-170.
Jordan, James S. and Frank C. Bellrose
1951. Lead poisoning in wild waterfowl. Urbana: Ill. Nat. Hist. Surv., Biol. Notes 26. 27 pp.
Kortright, Francis H.
1943. The ducks, geese, and swans of North America. Washington: Amer. Wildl. Inst. viii + 476 pp.
Low, Jessop B.
1940. Ecology and management of the redhead in Iowa. Ecol. Monog., 15:35-69.
Miller, Herbert J. and S. C. Whitlock
1948. Detroit River waterfowl mortality—winter 1948. Mich. Cons., 17(4):11, 15.
Morgan, Banner Bill
1944. Bird mortality. Passenger Pigeon, 6(2):27-34.
Musgrove, Jack W. and Mary R. Musgrove
1947. Waterfowl in Iowa. rev. ed. Des Moines: Iowa State Cons. Comm. ix + 124 pp.
Nord, Warren H.
1941. A technique for removing lead from gizzards of living waterfowl. J. Wildl. Mgmt., 5(2):175-179.
Pirnie, Miles D.
1935. Michigan waterfowl management. Lansing: Mich. Dept. Cons. xxi + 328 pp.
Reid, Vincent H.
1948. Lead shot in Minnesota waterfowl. J. Wildl. Mgmt., 12(2):123-127.
Stewart, Robert E., Aelred D. Geis, and Charles D. Evans
1958. Distribution of populations and hunting kill of the canvasback. J. Wildl. Mgmt., 22(4):333-370.
Toner, G. C.
1940. Duck mortality in the Catarqui marshes. Can. Field-Nat., 54(7):104-105.
Wetmore, Alexander
1919. Lead poisoning in waterfowl. U. S. Dept. Agric., Bull. 793. 12 pp.
Wilson, Etta S.
1922. Enormous flock of canvasback visit Detroit River. Auk, 39(2):250-251.
Wood, Norman A.
1951. Birds of Michigan. Ann Arbor: Univ. Mich. Press. Museum Zool., Misc. Publ. 75. 559 pp.
Yocom, Charles F.
1951. Waterfowl and their food plants in Washington. Seattle: Univ. Wash. Press. xvi + 272 pp.

A POSSIBLE RELATIONSHIP BETWEEN AQUATIC INVERTEBRATES AND AVIAN BOTULISM

WAYNE I. JENSEN AND JACK P. ALLEN
U. S. Fish and Wildlife Service, Brigham City, Utah

The epizootiology of wildlife diseases is never a simple field of research. That the study of avian botulism has been unusually complex is evident from its history. Twenty years elapsed between 1910, when "western duck sickness" became generally recognized as a serious menace to aquatic birds in the United States, and the publications of Kalmbach (1930) and Giltner and Couch (1930), which presented conclusive evidence that the disease was a form of botulism. Although their investigations left no doubt that the disease in birds resulted from the ingestion of the toxin of *Clostridium botulinum* type C, today—thirty years later—the substrates utilized by the bacterium for growth and elaboration of toxin under natural conditions are not known with certainty. Identification of these natural substrates is the ultimate aim of the study reported here.

The idea that the tissues of invertebrate animals (so commonly present in epizootic areas) might satisfy the nutrient requirements of *Clostridium botulinum* type C is not new. Kalmbach (1934), after suggesting that the organism may grow in the masses of algae cast up on the mud flats, added the comment, "That they (algal masses) harbor in their skeins many minute organisms that may contribute to toxin production there is little doubt—." In the same publication, he states: "During the season of 1931 the many least and western sandpipers that perished at Tule Lake were feeding extensively on larvae and pupae of hydrophilid beetles in cocoons formed in the masses of algae on which these dimunitive shore birds walked in search of food. The finding of the remains of many of these larvae in the stomachs of the dead, coupled with the demonstration of *Clostridium botulinum*, type C, in some of the dead larvae, strongly suggests the particular medium through which these birds, and probably few other species, obtained a lethal dose of toxin."

Laboratory studies have shown that many animal tissues are readily utilized as culture media by *Clostridium botulinum* type C. Hobmaier (1932) developed toxic cultures of the bacterium in the carcasses of beetles, grasshoppers, fly larvae, mollusks, and fish. Using the carcasses of chironomid larvae as the substrate, Quortrup (1940) prepared cultures of such toxicity that a 10 milliliter oral dose of the supernatant fluid was lethal to a duck. Similar experiments are on record in which the tissues of a variety of vertebrate and invertebrate animals were successfully employed as culture media.

Demonstrations of the capacity of invertebrate animals to satisfy the metabolic needs of *Clostridium botulinum* type C, as well as the known instability of botulinal toxin in the presence of adverse chemical and physical agents, formed a basis for the hypothesis that, under field conditions, toxin is formed within discrete organic particles rather than in solutions or suspensions of finely divided organic materials. A statement of this hypothesis is contained in a memorandum written by Kalmbach (1947) to a co-worker: "— with a concept of toxin being produced in organic particles more or less separated, we have a picture where toxin may be produced, held, and protected from adverse factors by its being enclosed possibly within the dermal covering of some arthropod or other organism." Bell, Sciple, and Hubert (1955), in a statement of their "microenvironment concept", suggested "(1) that *Clostridium botulinum* type C germinates, reproduces, and synthesizes its toxin in small discrete particulate substances, possibly invertebrate carcasses; (2) that the particulate substances are in no wise dependent upon the ambient medium for nurture of the bacteria, but contain all of the requisites within them; and (3) that the toxin is probably in the bacteria which reside in the particulate materials, rather than in the form of soluble, freely diffused toxin." Support for the concept was provided by laboratory experiments in which the instars of two orders of insects suspended in distilled water supplied all of the requirements of the bacterium for growth and toxin production.

It has been demonstrated experimentally that a variety of vegetable substrates will support the growth of *Clostridium botulinum* type C, but the opinion appears to be general among workers in this field that the bacterium prefers media of animal origin for toxin production. Hobmaier (1932), Coburn and Quortrup (1937), and Bell, Sciple, and Hubert (1955) have furnished experimental evidence which favors this opinion.

The fact that botulism outbreaks on the Bear River Refuge commonly start during the first two weeks of August suggested to Williams (1941) a possible relationship to a cyclic animal (or plant) activity. Although his study failed to incriminate any particular species of organisms, he believed that this approach to the problem held sufficient promise to justify its continuation.

The present study has been carried on for the past five summers (1955 to 1959) at the Bear River Migratory Bird Refuge for the purpose of establishing or disproving a relationship between aquatic invertebrates and avian botulism. Invertebrate populations have been followed in selected areas throughout the summer months in an effort to detect changes in population numbers or composition which appeared to be correlated with the appearance of the disease. While a considerable amount of work has been done in the laboratory and in the field to determine the suitability of invertebrate carcasses as toxin-producing culture media and to measure the capacity of living invertebrates to concentrate toxin by feeding on *Clostridium botulinum* cells, these studies will be referred to only insofar as they may assist in the interpretation of the population studies.

STUDY AREAS

Approximately 25,000 surface acres of Bear River water is impounded on the Bear River Refuge (Figure 1). Limitations imposed by time and personnel made it necessary to confine the invertebrate population studies to relatively small segments of this area.

Botulism epizootics rarely, if ever, affect birds on all parts of the refuge marshes with equal severity. There are areas within each unit where concentrations of sick and dead birds are found with sufficient regularity to suggest that they are sites of toxin production. There are other areas where evidence of the disease is seldom seen. These observations were taken into consideration in the selection of study areas. Rather than randomly distributing the invertebrate

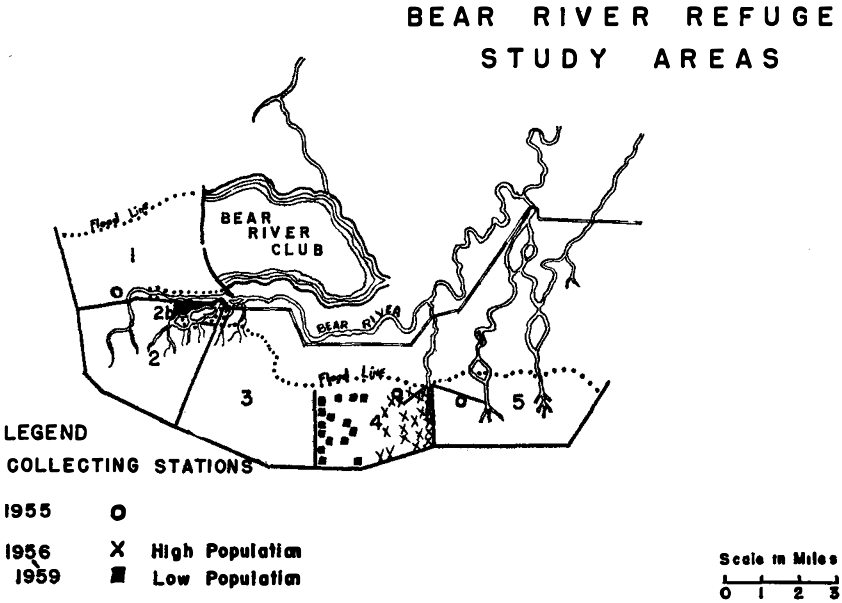

Figure 1. Distribution of collecting stations.

collecting stations within a unit, they were concentrated in areas which differed with respect to their history of botulism outbreaks. If aquatic invertebrates are in some way related to the disease, it was hoped that a comparison of the population curves in the two types of areas would offer a clue to the nature of the relationship.

Since little was known about the uniformity of the distribution of invertebrates in the Bear River marshes, the first year of the study (1955) was largely exploratory in nature. Three study plots of several hundred square yards each were established on Units 1, 4 and 5 (Figure 1). Differences between the numbers of invertebrates in samples collected within these areas and the numbers in samples taken periodically at nearby points for comparison indicated that intensive sampling of a single unit would yield more meaningful results.

Unit 4 was selected for study in the following four years. Observations of refuge personnel over a period of many years established the fact that botulism losses were consistently higher on the east half than on the west half of the unit. By distributing collecting stations over both halves, therefore, it was anticipated that any correlations that might exist between invertebrate population levels and the severity of the epizootic could be observed.

From 1956 to 1959, 38 collecting stations were established on Unit 4. In no case, however, were all of them used in a single year. In 1956 and 1957, collections were made at 27 stations, 12 on the east half and 15 on the west half. Because invertebrate numbers were consistently low on the west half, six of the stations in that area were discontinued in 1958, and six new ones were placed on the east half of the unit. In 1959, a control study area, *i.e.,* a non-epizootic area, was established entirely apart from Unit 4. All stations on the west half of Unit 4 were discontinued, and 20 new ones were placed on Unit 2B (Figure 1), a marsh area of about 300 acres with no history of botulism outbreaks. All stations on the east half of Unit 4 remained in their previous locations and four new ones were added.

METHODS

Both water and mud samples were collected at each station for invertebrate analysis. Since it has not yet been possible to detect a relationship between botulism outbreaks and any of the species of zooplankton (including the actively swimming organisms), only the macro-bottom fauna will be considered in this paper.

The general procedures for collecting and analyzing samples of the bottom species remained essentially the same during the five years of the study. Except in 1956, mud samples were collected with square metal tubes designed to cut and remove a core of specific surface area. Because of the semi-fluid consistency of the mud in some areas, the 6-inch-square tube used in the early part of the summer of 1955 would not retain the core. Substituting a 2-inch-square tube was helpful but did not entirely overcome the difficulty. In 1956, for want of a more satisfactory sampling method, a Tyler sieve (8 inches in diameter, 2 inches deep) was filled with mud collected to a depth of 2 inches. In 1957, a sampler was constructed (10 centimeters square, two inches deep) with a sliding metal bottom which could be closed to prevent loss of the sample. This instrument has been in use up to the present time.

Mud samples were taken to the laboratory where they were placed in a fine-mesh Tyler sieve and washed gently under running tap water to remove most of the soil particles. The invertebrates were transferred to shallow, white enameled pans for counting and classification.

In 1955, 10 mud samples were collected in each study area each week. From 1956 to 1958, each collecting station in Unit 4 was sampled once a week and, in 1959, two samples were taken weekly at each station in Units 2B and 4.

RESULTS

Many species of invertebrates were represented in the mud samples examined during the course of this study, but the predominant species fell into two groups—dipterous larvae (chiefly Tendipedidae) and oligochaetes. Time did not permit precise classifications during the routine counts, but representatives of all species were preserved for future identification.

Because the population counts at individual stations sometimes fluctuated widely from sample to sample, the average weekly counts of organisms found at all of the stations within a study area are used for the purpose of pointing out population trends. Table 1 and Figure 2 compare the average weekly counts of the predominant macrobottom fauna during July and August of the years 1955 to 1959. Species other than those in the two major groups are excluded, since their numbers were seldom large enough to increase the average counts by as much as 1.0. The study plot on the east side of Unit 4 in 1955 is included in the comparison, although it represents a much smaller area than those studied in the following years. Since the numbers of invertebrates on the west half of Unit 4 were consistently low and showed no significant trends, the figures for only two years are tabulated. The best available estimates of the numbers of sick and dead birds observed in the entire units during the period

TABLE 1. A POSSIBLE RELATIONSHIP BETWEEN MACRO-BOTTOM FAUNA POPULATION LEVELS AND THE SEVERITY OF AVIAN BOTULISM OUTBREAKS. BEAR RIVER REFUGE, JULY-AUGUST, 1955-1959.

Year	Study area	Species	Average numbers per 0.01 square meter[1] Week 1	2	3	4	5	6	7	8	Estimated sick and dead birds[2]
1955	Unit 4, east	Dipterous larvae	14.4	51.6	128.5	201.3	100.6	119.6	95.2	106.9	
		Oligochaetes	0.9	3.4	0	32.2	33.4	20.7	20.5	8.5	3887
		Total	15.3	55.0	128.5	233.5	134.0	140.3	115.7	115.4	
1956	Unit 4, east	Dipterous larvae	8.0	3.8	2.2	1.5	3.7	8.9	6.1	6.7	
		Oligochaetes	0	1.2	0.2	5.5	0.8	3.4	0	0	20[3]
		Total	8.0	5.0	2.4	7.0	4.5	12.3	6.1	6.7	
1957	Unit 4, east	Dipterous larvae	26.4	21.0	6.1	4.2	23.7	27.3	25.8	4.5	
		Oligochaetes	17.0	54.0	10.1	9.7	225.1	171.4	108.8	89.1	
		Total	43.4	75.0	16.2	13.9	248.8	198.7	134.6	93.6	678
1957	Unit 4, west	Dipterous larvae	2.2	2.7	0.3	0.2	6.9	3.3	6.1	1.1	
		Oligochaetes	0.1	0.4	0	0.1	0.5	1.3	0	0	
		Total	2.3	3.1	0.3	0.3	7.4	4.6	6.1	1.1	
1958	Unit 4, east	Dipterous larvae	53.8	35.8	26.8	18.0	47.7	25.0	43.6	37.5	
		Oligochaetes	97.6	73.2	114.2	97.1	113.9	66.2	65.8	85.0	
		Total	151.4	109.0	141.0	115.1	161.6	91.2	109.4	112.5	2522
1958	Unit 4, N. E. corner[4]	Dipterous larvae	48.9	50.0	45.2	48.2	81.7	29.7	57.6	58.1	
		Oligochaetes	94.5	105.0	118.2	139.6	147.0	85.0	98.6	109.1	
		Total	143.4	155.0	163.4	187.8	228.7	114.7	156.2	167.2	
1958	Unit 4, west	Dipterous larvae	4.2	6.9	3.1	1.3	3.0	0.5	3.0	13.0	
		Oligochaetes	0.2	0.4	0.2	0.5	0.8	0	0.4	0.3	
		Total	4.4	7.3	3.3	1.8	3.8	0.5	3.4	13.3	
1959	Unit 4, east	Dipterous larvae	43.0	41.0	36.6	29.0	36.0	23.5	24.9	41.0	
		Oligochaetes	30.0	74.0	37.8	65.0	34.0	37.0	36.8	59.0	50
		Total	73.0	115.0	74.4	94.0	70.0	60.5	61.7	100.0	
1959	Unit 2B	Dipterous larvae	33.0	45.6	47.2	49.0	24.0	45.0	39.7	47.0	
		Oligochaetes	32.0	22.0	17.0	14.0	9.8	15.0	15.2	14.0	0
		Total	65.0	67.6	64.2	63.0	33.8	60.0	54.9	61.0	

[1]Underscored totals indicate week in which an outbreak of botulism began.
[2]Estimated number for the entire unit. Accurate figures are not available for the two halves individually.
[3]This figure represents the total of sick or dead birds found occasionally throughout the summer. No real outbreak occurred.
[4]This tabulation includes only eight stations in the northeast corner of Unit 4, the area to which the outbreak was largely limited.

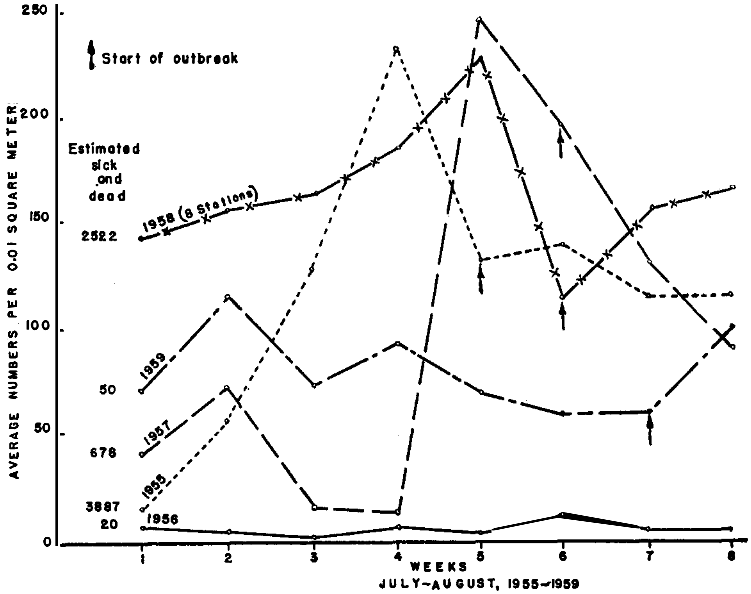

Figure 2. Macro-bottom fauna populations and avian botulism outbreaks.

of the study are shown for the purpose of showing the relationship between invertebrate numbers and the severity of the outbreaks.

It has been stated that botulism outbreaks are commonly confined to one or more segments of a unit. Seldom, however, is the epizootic area as clearly defined as it was in 1958. Such a large percentage of the sick and dead birds were found in the northeast corner of Unit 4 that the population figures for the eight stations located in that area were analyzed as a sub-group. As Table 1 shows, the populations reached a higher peak and underwent a sharper decline than was indicated by the average figures for the entire half unit.

DISCUSSION

Proof that the microenvironment concept is valid under the conditions existing in the Bear River marshes requires evidence (1) that invertebrate carcasses of the species indigenous to the epizootic areas will supply the requirements of *Clostridium botulinum* type C for growth and toxin production, (2) that invertebrates of these species are consumed by aquatic birds, and (3) that either the abundance of invertebrate carcasses increases or environmental changes favoring an increased rate of toxin production occur prior to the onset of a botulism outbreak.

It has been demonstrated repeatedly at the Bear River Research Station that carcasses of tendipedid larvae, oligochaetes, corixids and other species will support toxin production when incubated in the laboratory or buried in the mud of the marshes. Almost one-half of the invertebrate samples tested in 1959 (a year of mild botulism losses) contained measurable amounts of toxin after 3 or more days of incubation. Since these carcasses were not inoculated in the laboratory, toxin production was dependent upon the presence of ***Clostridium botulinum*** in the natural environment.

It is a well-established fact that aquatic birds feed on invertebrate animals. In order to obtain more information on the kinds and amounts consumed by ducks during the season of botulism epizootics, Sperry (1952) conducted a food habits study on 52 apparently normal birds collected on the Bear River Refuge. Remains of aquatic invertebrates (ranging from trace amounts to 80 per cent of the food material) were found in the digestive tracts of approximately 44 per cent of the birds. Tendipedid larvae were present in greater abundance than any other species. The fact that oligochaetes disintegrate quickly after death may explain the absence of identifiable carcasses in the food samples.

The onset of botulism epizootics has not yet been clearly correlated with any environmental factor. If an abundance of invertebrate carcasses is prerequisite to the production of lethal quantities of toxin, an increase in the mortality rate in one or more of the invertebrate populations would be expected to precede an outbreak. This appeared to be true in 1955, 1957, and 1958—the years in which appreciable botulism losses occurred (Table 1 and Figure 2). In each case, the beginning of the outbreak coincided with a sharp decline following the population peak of one or both of the predominant macro-bottom species. On the other hand, it would be expected in years of mild epizootics that invertebrate populations would be more stable, either at a high or low level. This was obviously true in 1956. In 1959, invertebrate numbers were higher than in 1956, but they did not approach the levels attained in the severe epizootic years, and their decline was less precipitous.

Although these data suggest a relationship between invertebrate carcasses and avian botulism, they by no means permit such a conclusion to be made. Even though it is eventually proved that certain species play a role in the epizootiology of the disease, there are undoubtedly many factors which influence the severity of an outbreak. Plant materials, while apparently less hazardous than animal tissues, might support toxin production at levels sufficient to precipitate an outbreak when present in large quantities. The occurrence of botulism epizootics on flooded grainfields favors this opinion. The toxigenicity of the predominant strains of *Clostridium botulinum* in an area undoubtedly has an effect on morbidity and mortality rates. It is known that strains isolated from an epizootic region may vary greatly in their ability to produce toxin. Toxicity tests on living invertebrates collected in the field have demonstrated that they are sometimes toxic, presumably by reason of having ingested the cells of *Clostridium botulinum.* If this occurs commonly, the numbers of living invertebrates, as well as of dead ones, would be expected to modify the course of an epizootic.

CONCLUSIONS

Since this paper is a report on work still in progress, final evaluation of the experimental data must be deferred until the study is completed. It appears, however, that the evidence in favor of a relationship between aquatic invertebrates and avian botulism is sufficiently strong to justify continuation of the investigation until definite conclusions can be reached.

LITERATURE CITED

Bell, J. Frederick, George W. Sciple, and A. A. Hubert.
1955. A microenvironment concept of the epizoology of avian botulism. Jour. Wildl. Mgt. 19: 352-357.

Coburn, Don, and E. R. Quortrup
1937. Report for work of November, 1937. Bear River Refuge. U. S. Fish and Wildlife Service, Department of the Interior.

Giltner, L. T., and J. F. Couch
1930. Western duck sickness and botulism. Science 72: 660.

Hobmaier, M.
1932. Conditions and control of botulism (duck disease) in waterfowl. Calif. Fish and Game 18: 5-21.

Kalmbach, E. R.
1930. Western duck sickness produced experimentally. Science 72: 658-659.
1947. Memorandum to Ralph Hervey. Bear River Research Station, U. S. Fish and Wildlife Service, Department of the Interior.

Kalmbach, E. R., and M. F. Gunderson
1934. Western duck sickness; a form of botulism. U. S. Dept. Agric. Tech. Bull. No. 411, 81 pp.

Quortrup, E. R.
1940. Quarterly progress report of the Bear River Wildlife Disease Research Laboratory. July-September. U. S. Fish and Wildlife Service, Department of the Interior.

Sperry, C. C.
1952. Unpublished data from the files of the Denver Wildlife Research Center, U. S. Fish and Wildlife Service, Federal Center, Denver, Colorado.

Williams, Cecil S.
1941. Report on certain aspects of duck sickness, Bear River Refuge. U. S. Fish and Wildlife Service, Dept. of the Interior.

DISCUSSION

MR. FREDINE: I think this is a very significant contribution. Mr. Jensen, did you attempt to produce botulism in ducks by feeding normal birds carcasses that were recovered from that particular area?

MR. JENSEN: We seldom can recover carcasses in sufficient quantities to do this. They decompose rather rapidly and by the time the sample is processed you seldom have enough left to work with. Of course, it has been done experimentally by feeding *Clostridium botulinum* spores to invertebrates and incubating the carcasses. In other words, the incubation has taken place in the laboratory rather than in the field.

MR. FREDINE: Are there any other questions?

MR. EARL FRYE [Florida]: I am curious to know whether these invertebrates are considered a factor in the food supply and in connection with waterfowl production on a river?

MR. JENSEN: Well, certainly invertebrates seem to be an important part of a duck's diet, particularly the ducklings. However, in 1956, which was the year in which invertebrate levels were extremely low, we noticed no difference in bird production or any evidence that they were suffering from a lack of food. This would indicate that invertebrates are pretty abundant in most years.

RACCOON PREDATION ON WATERFOWL

LEONARD M. LLEWELLYN

Patuxent Wildlife Research Center, Laurel, Maryland

CLARK G. WEBSTER

Remington Farms, Chestertown, Maryland

During recent years raccoons have increased in most parts of the United States. With this increase, raccoon predation on waterfowl also has increased. This paper discusses examples of raccoon damage to waterfowl and summarizes the results of control efforts.

CANADA GEESE

Eggs of the Canada goose are most vulnerable to raccoons during the laying period, when the nest often is unguarded. At the Patuxent Wildlife Research Center in 1955, F. M. Uhler found that all five first nests of a relatively new colony of geese were destroyed by one or more raccoons.

Poisoned eggs were placed in several nests and covered with nest material. The eggs disappeared and a few days later a large raccoon was found dead within 150 yards of the nest. One pair of geese re-nested successfully. All these nests were located on small islands not far off shore, where nesting material with which the geese could cover their eggs was scanty. In later years, when dead grass was supplied for nest material, only 20 per cent of the nesting attempts were unsuccessful.

After evidence of nest disturbance again in 1958, eggs poisoned with strychnine were placed in nests and a dead raccoon was found about 175 yards from one site. No more nests were destroyed that season. In 1959, 3 of 10 nests were destroyed by raccoons. All eggs were taken during the laying period. Once incubation starts, nesting Canada geese apparently are able to defend their nests against raccoons even where the small nesting islands are less than 50 feet from shore (Uhler, 1956).

GROUND-NESTING DUCKS

There are many examples of duck damage by raccoons. Glover (1956) found that during two years when raccoons were abundant in northwest Iowa, they destroyed at least 7 per cent of 146 unsuccessful blue-winged teal nests, or about 5 per cent of 186 nests under observation.

Mendall (1958) found in Maine that of 136 nests of ring-necked ducks destroyed by predators, raccoons destroyed at least 19 per cent, or about 5 per cent of 522 nests under observation. Ringneck nests on floating islands were seldom bothered by raccoons except where the islands were near a main shoreline.

In a study of mallard and black-duck nests on offshore shooting blinds in the Maryland portion of the Chesapeake Bay, Stotts (1958) found that raccoon damage accounted for 36 per cent of 33 nests destroyed, or 9 per cent of 133 nests under observation. Stotts noted also that blinds more than 100 yards from shore appeared to be visited less by raccoons than those located closer to shore. Other studies by Hammond and Mann (1956) and Stotts (1958a) have shown that nesting success is considerably greater on offshore islands free of mammalian predators.

F. M. Uhler found that raccoon predation on mallards was heavy on a 7-acre pond at the Patuxent Research Center. The mallards, of semi-wild stock, nested both on the ground and in artificial structures that had been provided to prevent crow damage. The artificial nests were wire cylinders of heavy poultry netting, interwoven with orchard grass. The cylinders were 2½ to 3 feet long. They were mounted horizontally on steel fence posts and placed over the water. The cylinders protected the mallard eggs from crows, but raccoons soon began pilfering the nests and over a period of 4 years they destroyed all of 20 nests in cylinders and 24 on the ground. Nests in cylinders were then protected further by mounting a smooth strip of sheet metal on the channel side of the fence post. This strip, 8 inches wide by 36 inches long, was mounted with the long axis against the post to discourage climbing. This technique, although not yet tested fully, has shown promise in preventing raccoons from climbing the posts and reaching the nest cylinders.

At Remington Farms on Maryland's Eastern Shore, predation on mallard nests has been heavy. Each year eight to ten thousand mallards are reared artificially and released. Those surviving the winter nest in the wild the following spring, but very few young are hatched. Both raccoons and crows rob the nests. Prior to the 1958 nesting season, artificial nesting cylinders were erected over water at several ponds. In addition, nest boxes, open at one end, were equipped with floats and anchored in various ponds. Raccoons destroyed 30 (60 per cent) of 50 nests under observation. Only one was known to have hatched. Others were either abandoned by the ducks or pilfered by crows. In 1959, all nesting structures were replaced by others of a new design. These were equipped with 2-foot-long tunnels, which successfully discouraged crows. Each mounting post was equipped with a sheet metal cone 30 inches in diameter to deter raccoons. Nest losses, which were low, occurred only before guards were attached or when guards were fastened too near the ground.

No systematic study was made of ground nests. However, most of those observed some distance from ponds were successful, whereas those located near ponds were destroyed, most often by raccoons. This may be explained in large part by the fact that raccoons use shore lines for much of their foraging. In managed ponds where raccoons are abundant, vegetation or other features of the habitat might be manipulated to encourage nesting sufficiently far from the shore line to reduce disturbance by raccoons.

WOOD DUCKS

Even the nests of hole-nesting ducks, notably wood ducks, are not safe from raccoon depredations. In Illinois, Bellrose (1953) ranked the raccoon as No. 1 predator on wood-duck nests. Over a period of seven years, raccoon damage accounted for 37 per cent of all nests destroyed. Though fox squirrels pilfered more nests, raccoons killed one incubating hen for about every three nests raided.

This disturbance by raccoons was reflected in the behavior of the ducks. In areas of raccoon abundance, wood ducks were much more easily flushed from their nests. If a nest was destroyed, the hen would select a new location, usually within a half mile of the previous one. When a nesting was successful, she usually returned the following year to the same site. In areas of heavy nest predation, nesting populations declined, but in areas with at least 50 per cent nesting success the population increased over a period of years.

Raccoons may not visit nest boxes the first year or two after they are erected. But it is the usual experience that one eventually will investigate and discover a nest of eggs. Thereafter, it apparently seeks eggs in each box it finds.

In Vermont, Miller (1952) found that raccoons destroyed 32 per cent of 50 clutches of eggs the second year after nest boxes were erected. He stated that low water prevailed throughout the summer and raccoons actually appeared to follow the biologist as he visited the boxes.

At the Patuxent Wildlife Research Center no eggs were taken the first year that wood ducks nested in boxes. The second through the fifth year nest destruction was low to moderate. During the sixth nesting season, however, 88 per cent of 24 nests in one particular area were destroyed by raccoons. Most of the damage could have been done by a single animal since the area involved was within the usual range of a raccoon. Elsewhere at Patuxent, where nest boxes were scattered over a wide area, none was disturbed.

In Connecticut, Beckley (1956) found that predation was very low where nest boxes were located in small, isolated groups. The boxes were situated on 156 ponds, usually one to four per pond. More than half of the boxes were used by wood ducks.

In Massachusetts, more than 3,000 nest boxes at 146 sites provided considerably more boxes per location than in the Connecticut study (McLaughlin and Grice, 1952). This apparently increased the chance of raccoons discovering the eggs. Over a three-year period, raccoon damage accounted for more than 41 per cent of all nest failures or more than 15 per cent of all nests under observation.

Various methods have been used to make wood-duck nest boxes raccoon-proof. In central Illinois it was found that a 3 by 4-inch oval entrance would exclude raccoons (Bellrose, 1953). And in Massachusetts, a 4-inch-diameter hole apparently prevented the heavier raccoons in this area from entering (McLaughlin and Grice, 1952). To protect entrances from being gnawed larger, Illinois workers masked the hole with a piece of sheet metal. Boxes used in the Massachusetts study were provided with a wooden tunnel, 4 by 4 inches inside and 10 inches long.

At the Patuxent Research Center, raccoons were trained to attempt to enter boxes. Of all animals tested, 88 per cent were able to go through both 3 by 4-inch metal elliptical entrances and 4 by 4-inch wooden tunnel-type entrances. Raccoons, 9 pounds or less, could go through both entrances with ease, but animals over 10 pounds experienced difficulty or were not able to enter. Since individuals weighing less than 9-10 pounds are present in most populations, it is virtually impossible to exclude raccoons completely by use of the above minimum-sized openings. Llewellyn (1949) found a significant difference in the weight of raccoons at Patuxent in a year of mast abundance from the weights of two successive years of mast failure. When the food supply was low, the raccoons weighed 30 to 50 per cent less than in years when food supply was abundant.

Raccoons can be prevented from entering nest boxes by the old method of placing a conical sheet-metal guard around the post below the nest box, but this method is costly and cumbersome. Unless the guard is well secured, it will come apart or tilt, and permit the raccoon to pass. Various methods of constructing or erecting nest boxes to exclude raccoons were tested with penned raccoons on the Patuxent area. Although several boxes of new design were tried, none was successful in excluding raccoons. Tests with the sheet metal, conical-roofed nest box developed by Bellrose (1953) showed that if a raccoon could reach the roof peak, it could climb up, grasp the top with its hind feet and lower itself to the entrance.

Two satisfactory methods of erecting boxes were devised (Webster, 1958). The first, for use on trees, was a metal bracket which held a sheet-metal nest box 2 feet out from the trunk. A second method was devised for mounting a nest box on a metal post. This method required that the metal box be bolted tightly to a channel post free of holes or extrusions that would provide a toehold.

DIRECT CONTROL PROCEDURES

Direct control usually provides only temporary relief, and must be a continuing process. Trapping, hunting, and poisoning are the common control measures. Trapping and hunting are impractical because they are time consuming, inefficient, and non-selective.

Uhler (1956) found that poisoning by the use of strychnine-treated eggs was effective in controlling raccoons damaging mallard and Canada goose nests. Eggs from abandoned nests, or chicken eggs, were treated, plainly marked as being poisionous, and placed in dummy or robbed nests.

Poisoning cannot be recommended at this time for widespread control of raccoons on wetlands that are important in the production of waterfowl. Further experimentation will be needed to find safe methods for use in the field. Poisoning is objectionable if it is not highly selective, for desirable kinds of animals may be killed. Furthermore, many local and State governments have regulations governing the use of poisons, and this fact must be taken into account in both experimental and operational use of poison.

SUMMARY

Raccoon damage to waterfowl nests has increased as the raccoon population has increased. Examples are given of raccoon damage to nests of Canada geese, ground-nesting ducks, and wood ducks. Damage control efforts are summarized: Poisoned eggs have been used to prevent damage to Canada geese. Preliminary trials have been made of artificial cylinders for preventions of damage to mallards. Wood ducks nesting in artificial structures have been protected by reducing the size of the box opening, by modifying the entrance by addition of a tunnel, by placing guards on the mounting posts, and

by using other special methods for mounting the boxes. All methods are not uniformly successful in all areas. Direct control of raccoons by poison is discussed.

LITERATURE CITED

Beckley, O. E.
1956. Wood duck nesting box program progress report 1953-1955. Conn. State Bd. Fisheries and Game. 2 pp. text, 19 pp. tables, mimeo.
Bellrose, Frank C.
1953. Housing for wood ducks. Ill. Nat. Hist. Surv. Circ. 45, 48 pp.
Glover, Fred A.
1956. Nesting and production of the blue-winged teal (*Anas discors* Linnaeus) in northwest Iowa. J. Wildl. Mgt. 20(1): 28-46.
Hammond, M. C., and G. E. Mann
1956. Waterfowl nesting islands. J. Wildl. Mgt. 20(4): 345-352.
Llewellyn, Leonard M.
1949. Effect of mast failure on a raccoon population. Address given to Am. Soc. Mamm., Washington, D. C. 1-8 pp.
McLaughlin, Charles L., and David Grice
1952. The effectiveness of large-scale erection of wood duck boxes as a management procedure. Trans. N. A. Wildl. Conf. 17: 242-259.
Mendall, Howard L.
1958. The ring-necked duck in the Northeast. Univ. of Maine Bull. 60(16): 1-317, Second Series No. 73.
Miller, William R.
1952. Aspects of wood duck nesting box management. Proc. 8th N. E. Fish and Wildl. Conf. 1-6 pp., mimeo.
Stotts, Vernon D.
1958. Use of offshore duck blinds by nesting waterfowl in the Maryland portion of the Chesapeake Bay and its estuaries. Proc. S. E. Assoc. Game and Fish Comm. 12: 280-285.
1958a. Black Duck Studies Final Report, Md. P-R. W-30-R-7. 1-141 pp., mimeo.
Uhler, Francis M.
1956. New habitats for waterfowl. Trans. N. A. Wildl. Conf. 21: 453-469.
Webster, Clark G.
1958. Better nest boxes for wood ducks. U. S. Fish and Wildl. Serv. Wildlife Leaflet 393, 1-18 pp.

DISCUSSION

MR. STULA [Connecticut]: Did you run into any case of secondary poisoning in connection with these control measures?

MR. LLEWELLYN: There were no secondary poisonings reported, but we must admit that there were some incidental poisonings of animals that we were not after. However, we have no evidence of secondary poisoning.

MR. PROGULSKE [South Dakota]: It is interesting to note the status of the raccoon around the continent. In South Dakota it is considered a nuisance animal and, of course, the terrain is quite different there. However, we have a very high population and some very large raccoons. In South Dakota, the Legislature, two years ago, considered putting a bounty on them.

I am carrying on somewhat of a restricted research on raccoons, trying to find out population figures, and so forth. In my project I have encountered complaints from farmers relating to poultry being lost, as well as sweet corn. We have been using poisoned eggs to fight them. Further, we do not as yet have any population figures but I do want to point out that our raccoons are very large. I think we have some weight records of 20 and 30 pounds.

MR. LLEWELLYN: I am surprised at some of those weight figures. We have some figures in our area which I consider to be from reliable sources, running anywhere from 8 to 12 pounds and the largest being 16 pounds. In so far as the bounty is concerned, I think that is a deplorable situation. The 'coons with their high population have been here now for almost 20 years and we are going to have to live with them.

FISH AND WILDLIFE MANAGEMENT ON WATERSHED PROJECTS

ROY A. GRIZZELL, JR.
Soil Conservation Service, Decatur, Georgia

Each of us lives on a watershed. We should realize, then, the importance of controlling water where it falls. All too often we read or see the effects of flash floods on small watersheds with loss of life, property, and resources. Each year floods cause an estimated billion dollars of damage. Half of this damage occurs in upstream watersheds. The small watershed program of the Federal Government was inaugurated to reduce these damages and to conserve our soil and water resources.

The Soil Conservation Service, as the agency with technical responsibility, furnishes assistance to local organizations under three Federal Authorizations. They are: (1) The Flood Control Act of 1944 involving 11 river basins; (2) The Pilot Watershed program included in the U. S. Department of Agriculture Appropriation Act of fiscal year 1954, involving 62 projects; and (3) The Watershed Protection and Flood Prevention Act authorized by Public Law 566, 83rd Congress and amendments involving watersheds of less than 250,000 acres.

Watershed projects must be initiated by local organizations. Individuals, local groups, states, and federal government all share the cost.

There is a basic difference between the *upstream* approach and the *downstream* approach to watershed management. The downstream projects are designed to control flood waters with structural measures such as dams and levees. Upstream projects deal with water conservation and treatment of all watershed lands. The practices employed on upstream watersheds include:

1. Establishing vegetation on critical silt producing areas.
2. Planning and establishment of all applicable soil and water conservation practices on farms and ranches.
3. Establishing perennial vegetation on road ditches and cuts.
4. Floodwater retarding structures.
5. Farm ponds.
6. Stream channel improvement practices.

Technical guidance in developing the fish and wildlife resources of a watershed will usually be furnished by the Soil Conservation Service. The SCS in Georgia now has a full-time watershed biologist. Some states are developing management programs on a cooperative basis. An outstanding example is Kentucky.

As of December 1, 1959 the following measures have been completed in watershed projects throughout the United States:

1,114	each floodwater retarding structures
79,198	each farm ponds
287,773	acres wildlife area improvement
334,114	acres critical area vegetation

Not all watershed projects are suitable for a complete fish and wildlife management program. Maximum benefits will accrue, however, only when multiple purpose is given due consideration. Management of fish, waterfowl, and upland game resources are our most important concern. Let us examine them in detail.

A MULTIPLE-PURPOSE MANAGEMENT TOOL

Field trials have been conducted with floodwater retarding structures which have a drawdown slot in the overflow of 30 inches. The slot is operated by either inserting or removing flash boards. Soil Conservation Service engineers have also designed a gate that may be lowered. To provide more needed flexibility in the operation of a drawdown, we now recommend a 48 inch slot or gate. Among the advantages that will accrue are:

1. The control or suppression of undesirable weeds, such as alder, willow, buttonbush, briars, and other woody plants.
2. Exposure of shallow edges that may be planted to food producing plants and feeding conditions for wild ducks and geese.
3. Periodic correction to secure useful fish populations.
4. Mosquito control for public health.
5. Domestic or agricultural water supplied below structures.

FISH MANAGEMENT

Most watershed projects involve the construction of floodwater retarding structures. Many of these have conservation pools, that range in area from four acres to more than 100 acres, with an average size of about 10 acres.

There are important differences between the small floodwater retarding structures designed by the Soil Conservation Service and the larger reservoirs built by the Tennessee Valley Authority, the Reclamation Service, and the Corps of Engineers. The latter usually involve extreme fluctuations of the water level for flood control, power, irrigation, and navigation. Small watershed structures are designed to store flood water temporarily. The flood water is slowly and automatically released downstream until the level of the conservation pool is again reached. The conservation pools of floodwater retarding structures are of two management categories, warm water and cold water. The majority will be managed as warm water habitat.

If the conservation pool is to be managed for fish, wild fish usually must be removed from watershed streams. From experience in Georgia we know that the use of rotenone is practical to kill the wild fish in most small streams. Where rotenoning is not practical, the pool should be left dry until after the spawning season, or drained, then filled and stocked immediately with game fish.

Warm water impoundments are usually stocked with bass, bluegills, and red-ear sunfish through the cooperation of the U. S. Fish and Wildlife Service and State Fisheries Commissions. Landowners are cautioned against fishing until the bass have been stocked for a year and have shown evidence of successful spawning. Field trials by SCS biologists in Georgia are in progress to study the advisability of adding catfish to the stocking ratio. Channel catfish offer the most promise. Determination will be made to see if channel catfish will spawn naturally in or above the reservoirs as they have in Texas and Oklahoma. Some impoundments will have artificial spawning devices such as kegs, barrels, drums, rock slab caves, and boxes placed in two to six feet of water to determine their use for spawning.

Until recently the fertilization of water in flood water retarding reservoirs seldom was recommended, due to excessive water flows. Recent field trial work by W. W. Neely, SCS Biologist, South Carolina, and others prove that overflows taken from the reservoir bottom make the fertilization of many impoundments practical.

Floodwater retarding reservoirs involving cold water streams present a challenge in managing both the impoundment and streams for trout and smallmouth bass. In the Southeast, projects involving cold water streams usually occur in the mountains and the retarding pools are smaller than on warm water streams.

To preserve the cold water for trout or smallmouth bass below structures the overflow is taken from the bottom, rather than the top of the reservoir. At the same time a more suitable habitat for trout or bass within the impoundment is provided by a deeper layer of cold water and available oxygen. The U. S. Fish and Wildlife Service and the Soil Conservation Service have cooperatively worked out a modification of the drawdown well to take water from the bottom strata.

In the Southeastern States cold water impoundments are stocked with rainbow or brook trout at the rate of 200-300 per acre. Subsequent restocking will depend on fishing pressure and the availability of wild hatched fish from the stream above the impoundment.

Most watershed projects improve the stream fishing. For example, the streams in the Settingdown Creek project in northeast Georgia formerly were filled with silt and sand and often dried up in summer and during droughts. Fishing was poor or non-existant. Now the stream runs clear all the year and fishing is excellent.

WATERFOWL MANAGEMENT

Floodwater retarding reservoirs attract waterfowl, especially ducks. Without special management efforts to produce food for them, the ducks do not stay. Smartweeds and barnyardgrass can be grown around the shallow edges and such plants as naiad and various potamogetons may occur as submerged aquatics. Unless the watershed area is stabilized to prevent the influx of silt the valuable aquatics will not grow in reservoirs. Feed produced naturally by edge plants and aquatics is seldom enough; therefore agricultural methods of food production for waterfowl are needed, at least in the wintering areas.

The most effective way to produce duck food in a watershed impoundment is by drawdown. The water is lowered by use of a drawdown slot during the summer growing season, the exposed shoreline planted to a choice food and flooded during the winter.

Field trials have been conducted on Noonday and Settingdown Creek projects in Georgia using browntop millet, Japanese millet, chicken corn, Texas millet, and several smartweeds. All have produced good seed crops. Japanese millet and the smartweeds are usually best for reservoirs due to the minimum amount of ground preparation needed and because they withstand temporary flooding. Where the ground is not prepared by agricultural machinery, biennial drawdowns are preferable to annual drawdowns. This reduces the encroachment of undesirable competing weed species with the food producing plants.

Areas of flat land below reservoirs will grow food best for wintering waterfowl. Duck fields on open flat land may be constructed, or woodland duck ponds can be established. Both require a low-level dike around the area, with a drain gate and control structure at the lowest elevation. Water from the floodwater reservoir is used to flood the fields or woodland ponds in the winter.

Fields are planted to choice duck foods such as browntop millet, corn, or chicken corn. To secure high yields the best cultural methods, including fertilizer, should be used. Often the best technique involves planting alternating strips to millet and corn. The flooded millet strips provide open water for incoming ducks.

In woodland ponds choice natural food producing trees such as oaks and beech are favored by thinning or weeding out undesirable species. Water is removed after the ducks leave for the breeding grounds. Trees thrive under this type of management but woodland duck ponds must be drained each spring or the trees will die. Open areas in woodland ponds may be planted to smartweeds, Japanese millet, or barnyardgrass. If agricultural machinery can be used, browntop millet may be chosen. Corn is not normally suited to woodland duck ponds due to raccoon depredation.

Excellent wood duck nesting habitat is present around many reservoirs. Where natural nesting trees are scarce, nest boxes may be built and erected on poles over the water surface or on trees nearby. Boxes have been erected around several Georgia reservoirs and excellent usage has been observed.

During the past year 53 species of waterfowl, marsh, and shorebirds have used the newly created water areas of one watershed project in North Georgia. Taking this one project and multiplying it by several hundred, we foresee a tremendous promise for the good of many fish and wildlife species.

UPLAND GAME MANAGEMENT

Watershed work plans provide for the stabilization of critical silt producing areas in perennial vegetation or trees. Critical areas may be planted for food and cover to favor quail or other wildlife. With water nearby the essential requirements for a good habitat are present. In Georgia, bicolor and sericea lespedeza have been extensively used as food and cover for quail. Other areas have been planted to perennial grasses and clover for deer and turkey.

Spoil banks from channel excavations have been planted to quail food mixtures such as browntop millet, Korean lespedeza, cowpeas, and perennial tickclover. Other similar areas have been planted to perennial grasses and clover for deer and turkey.

LOOKING AHEAD

This paper has reported actual accomplishments in the Small Watershed program in Georgia. No mention has been made of the hundreds of farms and ranches included in a project. By working with these people, wildlife benefits in a watershed will be even more significant through soil and water conservation practices of cooperators participating in the soil conservation district program.

Potential management programs for other fish and wildlife species not mentioned here are present in other parts of our country such as:

1. The development of upland areas adjacent to floodwater retarding structures as goose range.
2. Pheasant nesting and habitat development.
3. Development of duck nesting habitat on the northern breeding

grounds around reservoirs and marsh and pit enhancement projects on adjacent areas.

4. Habitat establishment for furbearers.

Public Law 85-865 amended Public Law 566 to authorize the Secretary of Agriculture to give technical and financial assistance to install fish and wildlife measures in small watershed projects. Federal financial assistance may be provided up to 50 percent of the installation costs. Assistance will be given only to qualified state agencies and local organizations. Private groups or individuals desiring to add fish and wildlife facilities for their own use may negotiate with the sponsoring organization to pay in full the costs of the projects. Public access is required where cost sharing is involved. The following types of fish and wildlife measures are eligible for Federal technical and financial assistance when included in a project work plan:

1. Storage capacity in reservoirs for fish and wildlife development.
2. Modification of reservoir structures for fish and wildlife development.
3. Stream channel improvement for fish and wildlife development.
4. Marsh and pit development.

Several states are cooperating in this program. Opportunities are available for many more.

The small watershed program is gaining momentum. We thus have a broader concept of resource use developing with watersheds—involving soil, water, plant, fish, and wildlife management. The use we make of these opportunities will depend to a great extent on the effort exerted, development of new management practices, application of known techniques, and a close working relationship between the agencies involved.

SUMMARY

Techniques in fish and wildlife management on small watersheds are many and varied as part of the approach to soil and water conservation and the prevention of floods.

A multiple-purpose drawdown slot in the overflow of reservoirs provides for control of undesirable weeds, waterfowl management, fish management, mosquito control, and downstream water supplies.

Floodwater retarding reservoirs are favorable to fish management for both warm and cold water species.

Waterfowl management within the impoundments and below the structures, is both practical and feasible.

A broader concept of resource use is developing as a result of the watershed program—involving soil, water, plant, fish and wildlife conservation.

DISCUSSION

MR. FREDINE: I for one think that the Soil Conservation service should be highly complimented for this approach to a highly difficult problem. Further, none of us should be complacent about the progress being made. Let's look at the table given here a few moments ago—that 287,000 acres of wildlife area improvement work has been done throughout the United States, as well as work on 79,000 farm ponds. Of course, these are impressive figures but, taken in connection with the nation as a whole, I would say it is a drop in the bucket in relation to the work that needs to be done. I know that you folks in the Soil Conservation Service are striving mightily to do this, and you have lots of problems.

I have one question to ask. Is the fact that public use of some of these areas is required if the Federal Government shares in the cost of the structures a deterent to the landowner to enter into this type of program?

MR. GRIZZELL: I can say from personal experience that it certainly is. We had a man all lined up to do some substantial development on a cost-sharing basis and as soon as he learned that the public would have free access to that area, according to our regulations, he dropped it like a hot potato. This boils down to the fact that if we are going to get participation under Public Law 566, we are going to have to depend on such agencies as state conservation departments, and maybe hunting and fishing clubs and organizations of that type.

STREAM VALUES, RECREATIONAL USE AND PRESERVATION

HAROLD E. ALEXANDER

Arkansas Game and Fish Commission, Little Rock

The theme of this Conference, "Resources and Citizenship" is particularly applicable to the purposes of this discussion, for nowhere in the maze of resource management is there more confusion and less recognition of the great variety of the problems which confront us than in the field of water management. The impact of technological development, both directly and as a result, has altered and changed the rivers, streams, marshes and swamps which were our geographic heritage; and these changes accelerate as human numbers soar and as more powerful machines and an expanded technology implement the further alteration of our environment. Even the vast oceans have felt the impact of man's energy, his technology and of the conflicts which result from his efforts to satisfy his insatiable desires.

Our rivers, which are the arteries of our land, have served as sources of supply for the water we require for our domestic and industrial uses, and as conveyors to carry away the debris from our homes and factories. It has been estimated that 50 million pounds of sewage solids are dumped, each day, into our flowing waters (Toffler, 1960). Synthetic compounds, poisons and atomic wastes have further polluted our rivers, to eventually turn up in our drinking water, since we have not found ways to remove these substances dangerous to our existence.

Vast dams, built by designated Federal Agencies, have been constructed across a majority of our river valleys, to hold water for irrigation, power production, flood control or other purposes, deemed necessary to our economic objectives. The economic justification for construction of some of these structures must be questioned when we note that estimated costs of irrigated lands runs as high as 10,000 dollars per acre (Carhart, 1951), that we have stored crop surpluses evaluated at nine billion dollars, and when we have placed over twenty-two million acres in the soil bank to take that land out of production.

In the lowlands, ditches built by the same or other agencies are gouging out and changing the character of natural streams, draining wetlands essential to the perpetuation of wildlife resources, and having profound effects on underground waters. The effects of subsidy payments, alone, has resulted in the drainage of hundreds of thousands of prairie pot holes essential for breeding grounds for ducks and geese.

At stream sources, in the uplands, other agencies are in the process of applying their own particular formulas of water management, specified by the limitations of their authorities.

Thirty-three government agencies, each operating within the realm of limited objectives and authority, are concerned with the management and manipulation of water (Miller, 1958). In many areas these water management objectives overlap. In others, they totally ignore values or uses which are of great importance in terms of present and future needs.

It has been estimated that completed and planned major water projects will cost us 70 billion dollars (Miller, 1958), which adds up to a staggering tax burden for the people of this country. Occasionally, somebody suggests that (maybe) some of our water problems are due to too much management, and he is, forewith, "relegated to that group of outcasts which live outside the fringe of reasonable society."

But the cost problems, emanating from these vast management plans, are not, at this time, our particular concern. We'll leave these financial considerations to "—the economist and Congress, who, (we hope), will somehow dig us out of the debts under which we stagger and let us keep enough of our incomes to pay the rent, the grocer and the dentist." (Alexander, 1959) As biologist and citizens, we are concerned with the impact of these vast programs for water management on all our resources. In this discussion we are particularly concerned with those intangible values which contribute to the scope and quality of the environment in which we live. We feel that the consideration of these values is essential to our future welfare and the perpetuation of our democratic society.

STREAMS AND VALUES

We have briefly considered some of the problems which result from our management of water; some of which management has been premised on questionable objectives which drive us to achieve an apparently higher standard of living. In the course of striving toward these objectives, we have ignored many of the physical, spiritual and emotional needs essential to our existence. We wish, hereafter, to confine this discussion to the problems which have arisen in our "management" of streams. These problems are crucial and demand our concerted and immediate attention; since the stream developments that have been effected, or are in the planning stage, will impose drastic alterations on most of our rivers, changing their character and nature and destroying many values which we believe are worthy of preservation.

In our management of streams, we have used two primary techniques. We have built dams to hold water for irrigation, navigation and flood control, and we have channelized them to carry the water away, as quickly as possible, on to the sea. These systems of management have produced profound changes. In addition to authorized purposes, they have created vast acreages of water which have been extensively used for recreation purposes. The contribution these impoundments have made to our needs for certain types of mass recreation and to the demands of an expanding population is obvious and recognized.

On the other hand, many of these developments have resulted in losses of economic, recreational and esthetic values which were inherent in the streams they covered up. We have carried this program of stream "management" to a point of diminishing returns, where what we have left is, in a great many instances, more valuable than what we can gain by further developments.

With reference to our usual system of evaluating water resources, we can state, without reservation, that unaltered and "undeveloped" streams have material values. They are extensively used for certain types of recreation, provide commercial and sport fishing, water supplies and have many other material values. But when we attempt to balance their economic worth against developments which would produce immediate monetary gains, we consistently come out second best. In assigning values to natural streams, we must emphasize intangible values, the significance of which defies the application of any monetary standards to define their worth. The intangible values we can assign to natural streams are real and are identical with those we attribute to good music, the arts and architecture, which command high prices in the market place. They include the concept of our democracy, our family relationships, and spiritual values. These things have not been and cannot be calculated in dollar terms. The values we attach to the preservation of streams must include a complete recognition of the high worth of these intangibles.

Before leaving the consideration of values, as they apply to our management of water, I would, further, like to question a doctrine which is often expounded to justify our courses of action in resource do in water management is designed to produce "the greatest good, management: that is the application of the concept that what we for the greatest number of people, for the longest period of time." In questioning the validity of this concept, I would ask: "Do we know, in terms of our limited knowledge, just what is the greatest good, over the longest period of time?" Certain courses of actions we took only a few short years ago, with this concept in view, are now considered to have been in great error. In no category of human endeavor is our failure to look at "anticipated preferences of the people" (Murie, 1950), more apparent than in those plans which will bring drastic alterations to most of our natural waters.

We need to recognize too, our diverse recreational needs. "Some like the sensation of careening across big water propelled by a 50 horse power motor; while others like the glint of a rapid in the sun, the exhilaration of propelling their own canoe, and solitude" (Alexander, 1959). There is room for the preservation of these separate and diverse opportunities in America.

There are historical, scientific and other values we can assign to streams, but the reply made by a member of a Mt. Everest expedition to the question, "Why do you want to climb that mountain?", is significant for us. He replied, "Just because it's there." I believe that answer is a good enough reason for saving some of the streams we like and wish to keep unmolested by man's handiwork.

STREAMS AND DEVELOPMENTS

That we are in the process of losing many of our streams, to which we assign values, and that we will lose most of them in the future unless actions are taken to preserve them, is all too apparent.

Battles have been fought to stem the tide of dam construction on the Columbia, and its tributaries where a hundred dams, if they are all built, will block the runs of salmon and other fishes to their spawning grounds.

Legislative approval of the questionable upper Colorado River project was blocked by conservation organizations, who protested plans to flood Dinosaur Monument. Numerous conservation organizations, and a few States, have protested the destruction of such great streams, as the Clearwater, the Cowlitz, the Allagash, the Flambeau, the Current, the Gunnison, the Potomac, and the Buffalo, but each day new plans are drawn and legislative actions taken to provide for eventual impoundment of these and other streams. Ben East, writing about western streams commented, "You name the stream; somebody has plans for it."

Recently, there has been an increasing awareness of all these plans which provide for the ultimate alteration of these and other streams, but when I wrote to one of our national conservation organizations to inquire as to actions 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).

Perhaps the outdoor writers have, in general, done as much as anybody else to give us a picture of what is happening to these flowing waters. In the outdoor magazines they have fought, with feeling and logic, the destruction of such rivers as the Salmon, the Gunnison and the Current.

Strangely enough, even though his efforts are concerned with the discovery of truth, few natural scientists have given attention to the problem of intangible values which we must recognize to preserve our streams. Scientists, it seems, have been more often concerned with quantity considerations, man hours of sport or fish in the creel, but seldom with problems of quality, while the public has been unaware of what is happening, indifferent, or lead by pressure groups whose primary interest is profits for themselves.

If we would save some of our natural streams we must be made aware of what is happening, we must recognize as real values and defend those intangibles we have defined, and we must take action. We haven't much time. If we don't do these things, most of our clear streams will, finally, be sacrificed on the altar of our technological developments.

STATES AND ATTITUDES

In an effort to evaluate the scope of the recognition of stream values, and the need for a positive program to preserve streams, a questionnaire was submitted to the Conservation Departments of forty-eight states. The acute interest in this problem was attested by the detailed returns. Forty-five of these states replied, and many furnished extensive comments in addition to their direct answers to the questions presented. Of those states which did not supply data, one commented that the problems were too extensive to be answered in this manner.

With reference to the extent of natural stream use for recreation, thirty-four states reported heavy use of certain streams, and twenty-two moderate use of others. Three states said their streams received light use. Twenty-five states indicated the use of their streams was increasing. One western State indicated a forty-four per cent increased use on one stream over a ten-year period. Forty-two states replied that they had streams having high recognized esthetic and scenic values within their borders and listed 148 of these streams by name. Only one State replied that they had few esthetic stream values worth saving, but another commented these qualities had, "different values to different people."

All but one of these stated emphatically that they had streams which should be preserved for these and their special recreation values. All listed fishing as the primary use, but other uses included canoeing, camping, picnicing, swimming and wilderness travel. The importance of fishing was exemplified by Colorado, which sold 286,961 fishing permits in 1958. Wyoming listed 200 angler days per mile of stream per year. But most states could not provide accurate data on fisherman use of streams.

Thirty-seven states listed streams that had been altered in such ways that they had lost recreational and intangible values. In the West, impoundments, channelization and land uses were the major causes. In the East and South, dams, pollution, channelization and land use had brought about these losses. Three states indicated they had suffered no losses. One southern state commented, "A project is planned for nearly every stream in the State." Oregon commented, "Somebody has plans for almost every bit of flowing water."

Twenty-five states indicated there had been objections to stream alterations within those states by conservation groups, while seventeen said some type of official action had been taken. In a few instances, particularly in the West, state conservation departments have directly opposed impoundments or other projects which would destroy stream values. Examples are Idaho, which has opposed dams on the middle Snake, and Missouri, which opposed dams on the Current and Eleven Point Rivers.

Thirty-nine states replied that developments had produced more recreational opportunities, but most indicated certain quality values were being lost. An eastern State commented, "A quantitative question (which) cannot be answered accurately—qualitative changes have generally been downward." Utah commented, "We are fast approaching the point where our major needs will be for higher quality stream fishing—alterations which will lower the quality or quantity of our stream fishing must be viewed with concern."

When questioned as to whether the need for impoundment type recreation facilities had been achieved, twenty said yes and seventeen said no. Some states gave qualitative answers. One said, "We would like to emphasize that the need for stream type fisheries are much greater."

There was disagreement as to whether watershed projects had enhanced or reduced stream values. Twenty-nine states indicated this type of developmnet had enhanced stream values, sixteen answered that they had not. Some qualified their replies with reference to the type of development.

Thirty-two states indicated that they had streams whose particular values were definitely recognized by the people of that state, and twenty-two stated that they had lost commercial fisheries or other values through developments. Virginia cited potential losses of oyster and shellfish industries worth "millions of dollars." In the Northwest, the loss of fisheries resources is of major concern.

All states agreed that streams had recreational, esthetic and intangible values worth saving, and that these were rapidly being lost to developments for other purposes, and all agreed that little concerted action had been taken to save these values. All but two (prairie) states agreed that there is an acute need for a positive program to save streams and their values from near extinction.

It is apparent that stream values are recognized most in the hills and mountains where their swift clear waters provide scenic and recreational features less conspicuous in the lowlands. This is particularly true in the mountains east and west, and in the Ozarks of Missouri and Arkansas. In those two states the famous float streams are disappearing. The famed upper White River is on the road to oblivion, and plans call for impoundment of most remaining streams. It is in these regions where impoundments are most rapidly obliterating our best streams. In a few years our streams will have been, largely, destroyed as we know them, unless a positive program for their preservation is established.

WHAT CAN BE DONE

Those who replied to the questions submitted to the conservation agencies recognized the acute need for immediate and direct actions to preserve streams and stream values in this country, and suggested the following courses of action.

Attention was called to the great "apathy" among state conservation agencies and national organizations, while other groups are "actively shaping state water laws to their own liking." A report commented, "We all claim to be interested in multiple use planning—, but I suspect that most agencies have their own definition of multiple use; one which places their particular use at the top of the list" (Pelgen, 1958).

It was suggested that conservation groups "co-ordinate" their efforts in a concerted effort to save streams. It is obvious that we, too often, operate as "splinter" groups and do not combine our efforts with others who feel and believe as we do with regard to these matters. Outright purchase or easements on streams with high recreational values was suggested. However, one state said, "The group most intimately affected must bear the brunt of any action—(and should not) rely on other interests."

Another state recommended "education of the public" as to what was happening and to enable them to recognize the worth of intangible values. A western state said, "—the greatest problem is keeping the public informed of what is happening to—areas of high esthetic and scenic value, and what the need for recreational areas will be in the future."

"Zoning" or classification of recreational areas and streams with recognized values was suggested. As an example, the province of Ontario, Canada has set-up land use designations, to include wilderness areas, lakes and rivers, which will not be developed, and which will retain their natural qualities into the future.

Legislation to "strictly prohibit" pollution was considered essential.

Evaluation of the "worth" of fish and wildlife resources, to give accurate data on which to base recommendations was proposed as a primary need.

Legislative action to set aside and reserve certain streams *now,* for recreational use, with the provision that developments be permitted "only if they would not adversely effect the withdrawn stream" was another recommendation.

Other proposals included: evaluation of future needs in terms of accelerated use; preliminary plans recognizing the value of streams; interagency reviews; national legislation to prevent loss of anadromous fishes; individual consideration for each stream in relation to its value; collection of data to put a value on streams; full compliance with Law 85-624; State River Basins programs to be carried out by the Conservation Agencies of the separate states; and a Federal system of "National Rivers."

The Hoover Commission and Water Policy Commission recommended the establishment of an impartial "Board of Review" for water projects. This is still a major need if we are to carry on a water program considering all values.

Congressional legislation to require interagency approval of power dams has been introduced.

One of the most interesting and workable proposals has been drawn up by Dr. John Craighead, of Montana State University (Craighead, 1959). This plan suggests a classification of rivers into: 1. Wild rivers, which will furnish wilderness-type recreation. 2. Semi-wild rivers, accessible by road. 3. Semi-developed rivers, and 4. Harnessed or Developed rivers; and provides lists of streams falling into these categories. Such a plan has been adopted by the Western Montana Game and Fish Association. It is definite; provides positive criteria for stream classification for preservation, and formulates a system of classification which can be expanded to define the use of rivers wherever they may be.

CONCLUSIONS

We are carrying on a wide variety of water management programs under the jurisdiction of numerous governmental agencies, whose separate activities are limited by their authorities, and which fail to consider many important uses of water.

We are "developing" most of our natural streams to gain material objectives, and failing to consider inherent recreational, intangible and quality values. These intangibles include esthetic, historical and spiritual values of the utmost importance, which are comparable to those recognized for the arts, our family relationships, and our concept of democracy. These values cannot be estimated in dollar terms.

There is an acute awareness that we are rapidly losing our high quality streams, and that a positive program is needed to save the values they have for us in a natural state. So far there have been only sporadic efforts to save our streams.

There is a recognition that natural stream values will increase in ratio to their relative scarcity.

The natural scientist, with notable exceptions, has given most of his attention to material considerations, and has failed to consider criteria by which intangibles could be recognized and which would lead to an understanding of the significance of these values.

In managing water resources we have applied the slogan "the greatest good for the greatest number of people," without clearly understanding what this doctrine might imply, or recognizing our diverse and changing needs, now and in the future.

We should realize that we are taking courses of action in water management which are irreversible. The hour is late. These mighty structures of concrete and steel which are drowning the intangible values our streams possess are also fettering our freedom to choose the kind of world in which we and those who come after us would live. The perpetuation of that freedom is essential to the preservation of citizenship in our democracy.

LITERATURE CITED

Alexander, H. E.
1959. Stream values, recreational use and preservation in the Southeastern States. Proc., 13th Ann. Conf. S.E. Assn. Game and Fish Commissioners. Pending.

Carhart, A. H.
1951. Water or your life. J. B. Lippincott Co., N. Y., 306 pp.

Graighead, J. J.
1959. Testimony before the Senate Select Committee on National Water Resources. Missoula, Mont., 11 pp., mimeo.

Miller, L. A.
1958. It all comes out of your pocket. Saturday Evening Post. 230(28): 25 and 67-70.

Murie, O. J.
1950. The defense of forest recreational areas against over-ambitious irrigation flood control and water power projects. Jour. Forestry. 48(1): 38-40.

Poole, Dan
Personal letter, March 24, 1959.

Pelgen, D. E.
1958. Recreation fish and wildlife in California's water development program. Cal. Dept. of Fish and Game, 11 pp., mimeo.

Toffler, A. B.
1960. Danger in your drinking water. Good Housekeeping. 150(1): 41-43 and 128-130.

TECHNICAL SESSION

Tuesday Morning—March 8

Chairman: JOHN L. SEUBERT
Assistant Chief of Game Management and Research, South Dakota Department of Game, Fish and Parks, Pierre, South Dakota

Discussion Leader: EUGENE H. DUSTMAN
Assistant Chief, Branch of Wildlife Research, U. S. Fish and Wildlife Service, Washington, D. C.

FIELD AND FARM RESOURCES

EVALUATION OF PHEASANT NESTING HABITAT IN EASTERN SOUTH DAKOTA

CARL G. TRAUTMAN
South Dakota Department Game, Fish and Parks, Brookings, South Dakota

Basic in any wildlife management program is the maintenance and improvement of habitat. Of eminent importance to the welfare of the ring-necked pheasant *(Phasianus colchicus)* is the maintenance and possible improvement of production habitat. The reality of the much discussed human population explosion and accompanying increasing demands upon agricultural land, accentuates the urgency for finding ways and means of increasing game production from the ever diminishing area of land available for wildlife purposes.

Cognizance of this problem has been shown by the many pheasant nesting studies that have been conducted throughout the United States. One of the most comprehensive of these has been that by Stokes (1954).

Limited knowledge had been obtained from small-scale studies in South Dakota; however, no comprehensive evaluation of nesting habitat had been attempted prior to this study, which was initiated in 1958. The principal objectives of the investigation were to determine the extent of pheasant nesting and brood production in the various cover types common to the eastern portion of the State's high-pheasant-density range.

The author wishes to acknowledge the assistance and advice of Dr. John L. Seubert, assistant chief of game management-research, who initiated the research project, and of Mr. Robert B. Dahlgren, research biologist, who assisted in the preparation of this manuscript. He is appreciative of the South Dakota Department of Game, Fish, and Parks Commission, who made the study possible; the excellent cooperation of South Dakota State College personnel; and the cooperation of the many farmers who permitted access to their farms.

DESCRIPTION OF STUDY AREA

The study area encompassed 36 square miles of the western portion of Brookings County in extreme eastern South Dakota.

Topography is gently undulating to undulating, interspersed with poorly drained soils and marshes. Soils are comprised of silt loams and loams of the western uplands, and belong to the Northern Chernozem soil series. The soil types of this area are Poinsette, Waubay, Ahnberg, and Parnell.

The area lies with that portion of the Great Plains region of the United States, characterized by extremes of summer heat and winter cold, together with rapid fluctuation of temperature. The mean annual precipitation is about 20 inches, and average temperatures for May, June, and July are 57.6, 67.4, and 73.7°F., respectively. Precipitation for the same months averaged 2.76, 3.98, and 2.31 inches (U.S. Department of Commerce, 1958). The average growing season is 136 days (Yearbook of Agriculture, U. S. Department of Agriculture, 1941).

Land use involves a general livestock and corn-grain economy, characterized by a corn-small grain rotation, which includes some legumes, flax, and grasses. The cover types that were considered suitable for pheasant nesting were classified into nine broad categories; strip cover, pasture, legumes, small grain, sloughs, flax, hayland, treeland, and idle farmland. Of the 23,040 acres comprising the area, nesting cover occurred on 16,065 acres or 70 per cent in 1958, and on 14,313 acres or 62 per cent in 1959. Proportional distribution of the various nesting cover types is shown for major cover types for both years in Table 1, and is detailed for all 1959 cover types in Table 2. Oats, pasture, flax, and alfalfa comprised 75 per cent of the cover in 1958, and 70 per cent in 1959. A marked reduction in the area of ungrazed pastureland was observed in 1959, as the result of deficient rainfall. Because of the resultant subnormal forage production, nearly all pastureland was continuously grazed in the latter year.

The residue from the previous year's vegetation, which constituted most of the nesting cover available at the onset of the main nesting season in early May, occurred in sloughs, fencerows, roadsides, field margins, railroad right-of-ways, and farm groves and shelterbelts (treeland). The area of nesting cover was increased substantially by late-May with the growth of alfalfa. Although small patches and occasional odd acreages of unmowed and ungrazed residual cover occurred throughout the grassland area of pastures and wild hay, most of the land among these cover types was relatively bare until the vegetation had attained appreciable growth by mid-June. The foregoing description of seasonal cover abundance also generally applied to grainland, flax, and tame hayland.

The study area lies within the eastern portion of the State's prime pheasant range. Pheasant density on this area in 1959 was estimated at 147 birds per square mile in mid-February. Although aerial census data are lacking for 1958, the spring breeding density for that year, as estimated from other surveys, probably was as high or higher than in 1959. The sex ratio in 1958 was 31 cocks per 100 hens and 35 in 1959.

STUDY DESIGN

The sampling designs used in this study were developed by the Iowa State University Statistical Laboratory, Ames, Iowa. Statistical

TABLE 1. COMPARISON OF HABITAT, NESTING, AND PRODUCTION DATA, SOUTH DAKOTA, 1958-59

	Per Cent of Total Cover Area[1]		Nests Per Acre		Per Cent of Nests Hatched		Per Cent of Total Production	
	1958	1959	1958[2]	1959	1958	1959	1958[3]	1959
Oats	27.7	23.1	0.38	0.54	39.4	40.4	27.0	22.9
Flax	14.5	11.1	0.14	0.41	62.5	35.6	7.6	8.4
Grazed pasture	13.6	23.1	0.23	0.37	25.0	33.9	5.3	14.0
Mowed alfalfa	12.3	12.0	1.31	1.57	7.6	6.2	8.0	5.1
Barley	5.5	6.3	0.67	0.62	25.6	47.3	6.0	8.0
Ungrazed pasture	6.6	0.7	0.70	1.30	28.3	40.8	8.5	2.0
Sloughs	4.5	4.3	1.11	2.33	27.3	23.6	8.9	11.2
Roadside	3.6	3.3	1.87	2.82	20.0	28.8	8.6	10.7
Wheat	2.7	3.0	0.14	0.57	100.0	55.0	4.0	4.6
Treeland	1.9	2.1	0.75	1.43	10.5	24.1	1.0	1.1
Wild hay	1.8	1.7	1.05	2.13	11.1	16.8	1.4	2.9
Tame hay	1.6	1.7	0.88	0.72	33.3	32.2	4.9	1.8
Field margin	1.2	1.0	1.50	1.38	13.2	......	1.7	....
Railroad 'way	0.6	0.6	1.75	1.35	41.2	40.7	2.7	1.8
Fencerow	0.4	0.4	11.64	12.96	11.8	6.4	3.0	1.9
Miscellaneous	1.5	5.6	0.97	....	23.8	....	1.4	3.6
All types	100.0	100.0	0.84	0.91	20.0	24.3	100.0	100.0

[1]Obtained from cover mapping.
[2]A combined ratio estimator (total nests divided by total acres searched).
[3]Obtained by multiplying the hatched nests per acre figure by the total acreage of each type as determined by cover mapping.

TABLE 2. ESTIMATES OF NESTING DENSITY, TOTAL NESTS, AND TOTAL ACREAGE, SOUTH DAKOTA, 1959

	Nests per acre		Coefficient of variation (in per cent)		Estimated number of nests		Per cent of total nests hatched	Estimated total acreage
	All	Hatched	All	Hatched	All	Hatched		
Alfalfa (Mowed)	1.57	0.10	10.82	31.08	2,571	159	5.1	1,637.9
Alfalfa (Conservation Reserve)	0.91	0.30	48.06	82.19	84	28	0.9	92.2
Sweet clover (seed)	4.49	1.04	3.68	48.72	362	84	2.7	80.7
Red Clover	1.32	......	38.20	....	56	......	....	42.2
SUBTOTAL					3,073	271	8.7	1,853.0
Tame Hay	0.72	0.23	40.29	56.04	174	56	1.8	240.0
Wild Hay	2.13	0.36	17.74	41.39	549	92	2.9	257.8
SUBTOTAL					723	148	4.7	497.8
Pasture (grazed)	0.37	0.13	14.65	21.80	1,292	438	14.0	3,457.0
Pasture (ungrazed)	1.30	0.53	21.23	40.72	157	64	2.0	121.2
SUBTOTAL					1,449	502	16.0	3,578.2
Fencerow	12.96	0.83	15.18	53.16	923	59	1.9	71.2
Roadside	2.82	0.81	12.95	21.95	1,163	335	10.7	412.2
Field Margin	1.38	......	34.42	....	198	......	....	143.4
Railroad 'way	1.35	0.55	37.60	52.00	140	57	1.8	103.9
Grassy Ditches	1.10	......	44.19	....	65	......	....	59.0
SUBTOTAL					2,489	451	14.4	789.7
Shelterbelt	1.43	0.16	24.10	68.40	305	34	1.1	213.8
Farm Grove	......	......	....	....	......	......	....	70.9
SUBTOTAL					305	34	1.1	284.7
Oats	0.54	0.22	10.08	17.65	1,700	686	21.9	3,149.0
Oats (Conservation Reserve)	0.21	0.10	68.79	68.83	60	30	1.0	291.6
Barley	0.62	0.29	23.38	23.57	531	251	8.0	860.3
Wheat	0.57	0.32	22.56	31.90	260	143	4.6	453.1
SUBTOTAL					2,551	1,110	35.5	4,754.0
Flax	0.41	0.15	17.02	24.59	739	263	8.4	1,792.2
Slough	2.33	0.55	11.25	20.27	1,481	350	11.2	635.9
Idle Farmland	3.19	......	31.02	....	46	......	....	17.5
TOTAL	0.91	0.22	5.58	8.96	12,866	3,129	100.0	14,203.0

interpretations presented in this paper were prepared under the direction of Mr. Jose Nieto de Pascual, member of the Laboratory Staff.

As a basis for the development of sampling methods, the township-size area was cover mapped using aerial photographs as base maps. Using these maps in 1958, the sample was drawn from the population of 5-acre plots located in each of the four corners of every quarter section in the study area. Thus, in each section there were sixteen 5-acre corner plots, in four rows (or four columns) of four plots each. The sample was selected by drawing two letters at random from a 4-by-4 Latin Square. Each letter would therefore locate four plots for the sample, and these plots would be in only one row and only one column of the array. Therefore, the sample consisted of eight corner plots per section, four corresponding to one letter and four to the other letter of the two selected from the 4-by-4 Latin Square. Thus we have two independent samples of four plots each, per section. One of these independent samples was called the "red" sample and the other the "green" sample. The Latin Squares were randomized before selecting the sample in every one of the 36 sections comprising the study area.

It is clear that the area outside the corner plots and within the study area had zero probability of coming into the sample. The motivation behind this restricted procedure was that it was considered mechanically difficult to locate plots away from the corners; it was assumed, furthermore, that the rate of nests per acre found for each cover type in the corner plots would be an appropriate estimate of this characteristic per cover type, regardless of the location of the cover type in the study area. This assumption was not contradicted for most of the results of the 1958 Study, from the 1959 results, which are unbiased since every portion of the area had a fixed positive probability of coming into the sample.

With the help of aerial photographs of the complete study area, from which the total area per cover type was estimated, an estimate of total production, (*i. e.*, total hatched nests) was obtained. The aerial photographs were indispensable, in 1958.

In 1959 the possibility of utilizing a strip sampling unit, laid out at random, was suggested. The feasibility of such a procedure with strip units was investigated and found very satisfactory. The design was therefore changed. The unit selected was a strip plot of 50 x 1000 feet, which comprises an area of 1.1478 acres. Every quarter-section was considered a stratum, and in each of these 144 strata a sample of 5 strip units was selected at random. Since every quarter-section is considered to have an area of 160 acres, the sample becomes proportionally allocated and thus becomes self-weighting.

The sampling method adopted in 1959 permitted the estimation of total acreage per cover type at the same time it produced the nests-per-acre figure; thus from the sample itself, we obtained estimates of total production without the need of previous knowledge of total acreage per cover type that was necessary in 1958. The need for aerial photographs was thereby eliminated; this was a major improvement over the 1958 study. The 1959 design, furthermore, opens the possibility of unbiasedly estimating total production for a much larger area, with appropriate design changes.

The long, narrow strip was considered a more efficient sampling unit than the square corner plot. Because the plot was narrow, the search for nests may be made more thoroughly in less time. The 1959 results had good precision with about 50 per cent reduction of the area canvassed in the 1958 study. By randomizing the location of the plots, the sample produced a reliable picture of the relative

---

[1]The rate of nests per acre for each cover type was estimated from formulas given by H. O. Hartley in his paper "Analytic Studies of Survey Data," published in the Memorial Volume in honor of Corrado Gini, issued by the Institute of Statistics, University of Rome, Italy, in 1959.

Let $j^{u}hi$ denote the acreage of cover type j observed in the i-th sampling unit of the h-th stratum ($i = 1, 2, \ldots, 5$; $h = 1, 2, \ldots, L = 144$) $j^{y}hi$ indicates the number of nests found in cover type j in the i-th sampling unit of the h-th stratum. Clearly, both $j^{y}hi$ and $j^{x}hi$ are random variables.

Following standard notation (e. g., Cochran, Sampling Techniques, Wiley, 1953), let N_h denote the total number of units in the h-th stratum, and n_h the number of units sampled therefrom.

The total acreage under the j-th cover type is estimated by

$$j\hat{U} = \sum_{h=1}^{L} (N_h/n_h) \cdot ju_h$$

where ju_h is the area under cover type j in the h-th stratum.

The total number of nests in the j-th cover type is likewise estimated by

$$j\hat{Y} = \sum_{h=1}^{L} (N_h/n_h) \cdot jy_h$$

The rate of nests per acre for the j-th cover type may be given by the "combined" rate estimator

$$\widehat{jy} = (j\hat{Y}/j\hat{U}) = (jy/ju)$$

where ju and jy are the total area in the sample and the total number of nests found in the sample for the j-th cover type. This is so because of the proportional allocation of the sample. An improved estimate can be given by the rate estimator

$$jr^* = \frac{n}{n-1} (\widehat{jy}) - \left(\frac{1}{n-1}\right) j\bar{r}_{st}$$

where n is the number of units selected in each stratum, and $j\bar{r}_{st}$ is the mean of the rates of the y and the x obtained from the five independent samples of size L, taking one unit per stratum. This estimator is presented in an unpublished paper by Jose Nietro de Pascual,

The variance of $\widehat{jy}$ may be computed from the formula

"Unbiased Ratio Estimators in Stratified Sampling," in process of publication.

$$\widehat{Var}\,(\widehat{jy}) = (1/j\hat{U}^2)\, h\Sigma = 1\ \widehat{Var}\,(jy_{hi} - \widehat{jy} \cdot ju_{hi})$$

proportion of the acreage in the cover types, since it automatically made the acreage in each cover type come into the sample with probability proportional to its size relative to the total acreage, including non-cover.

Some strata (quarter-sections), eleven out of the 144, were not canvassed in 1959 because of farmers' refusal to grant permission to search. However, an estimate of the area per cover type that would have been in the sample was obtained from aerial photos, and thus the estimate of total acreage per cover type was made properly. The rate of nests per acre found in the area searched was applied then to the estimate of total acreage, to find the total production per cover type. Information on total acreage per cover type was obtained from cover maps of the non-response areas. Estimates for the 133 strata canvassed, could be utilized to estimate the total study area by multiplying by a factor of (144/133). The non-response in 1958 merely reduced the sample size from which the estimate of the rate of nests per acre was made, since the total area per cover type was not made from the sample but from aerial photos. Since we did not know which cover type would fall in any sampling unit until after the sample was drawn, the 1959 survey may be visualized as one suitable to analytic studies.[1]

Data were collected both years during the period of June 10 through August 23. With the exception of flax, small grain, and tame hay, which were searched at the time of harvest, two systematic searches of sample plots were made each year. Nest searching crews consisted of eight to 13 wildlife students in 1958, and eight in 1959.

RESULTS

Total acres of cover in the sample was 1051 acres in 1958, and 512 acres in 1959. Sampling rate in 1958 was 6.5 per cent of the total cover area and ranged from a minimum rate of 3.2 per cent of the flax area, to a maximum rate of 12.5 per cent of the slough area. In 1959, the sampling rate was 3.6 per cent, a reduction of 55.4 per cent of the 1958 sampling rate, and ranged from 3.3 per cent of the grain and tree areas to 4.1 per cent of the flax area.

Overall nest density was 0.84 nest per acre in 1958, as compared to 0.91 nest in 1959 (Table 1), and at the 95 per cent confidence intervals, the 1958 data were not significantly different from 1959 (1959 C.I. 0.8069 to 1,0049). There also was no significant difference in total nests for both years. Coefficients of Variation for nesting densities in 1959 are presented in Table 2.

Fencerow[2] cover vastly outranked other cover types in nest density,

[2]Fencerow was defined as a standard width of two feet, one foot outwards from each side of the fence proper.

averaging 11.6 nests per acre in 1958 and 13.0 nests in 1959. Roadsides also ranked high among strip cover types with 1.87 nests per acre observed in 1958, and 2.82 nests in 1959. Among field types, the largest number of nests were found in alfalfa; 1.31 nests per acre in 1958 and 1.57 in 1959. Nest densities greater than one nest per acre also were observed in sloughs, wild hay, field margins, and railroad rights-of-way. As expected, ungrazed or only lightly grazed pastures outranked those which were heavily grazed. The lowest nesting densities were observed in oats, flax and grazed pastures. Other investigators of pheasant nesting habitat have reported on the degree of utilization of various cover categories, where the order of use was similar to that observed in this study (Baskett, 1941 and Hamerstrom, 1936).

Twenty per cent of all nests were hatched in 1958 and 24.3 in 1959 (Table 1). Low hatching success was observed in mowed alfalfa, wild hay, fencerows, field margins, and treeland; fair success in roadsides and sloughs; fair to good success in pastureland, railroad rights-of-way, barley, and oats; and excellent success in wheat and flax.

PRODUCTION

Estimates of total production were made for both years. The hatched-nests-per-acre figure was significantly higher the second year with 0.22 hatched nests per acre estimated for 1959, and 0.17 for 1958 (Table 3). With the exception of grazed pasture, roadsides, and sloughs, there was no significant difference in hatched nests per acre between cover types in 1958 and 1959. The total production of hatched nests also was estimated at 2696 for 1958 and 3129 for 1959. At the 95 per cent Confidence Interval for the 1959 result, the 1958

TABLE 3. VALIDITY OF HATCHED NESTS PER ACRE ESTIMATES, SOUTH DAKOTA, 1958-1959

Cover Type	1959 Estimate	95 Per Cent Confidence Interval 1959	1958 Estimate	Comparison of 1958 and 1959 Data
Alfalfa (mowed)	0.0969	0.0379 to 0.1559	0.10	Not Significant
Sweet Clover	1.0363	0.0467 to 2.0259	......	....
Tame Hay	0.2337	0 to 0.4905	0.29	Not Significant
Wild Hay	0.3564	0.0673 to 0.6455	0.12	Not Significant
Pasture (Grazed)	0.1266	0.0725 to 0.1807	0.06	SIGNIFICANT
Pasture (Ungrazed)	0.5309	0.1071 to 0.9547	0.20	Not Significant
Fencerow	0.8623	0 to 1.6873	1.37	Not Significant
Roadside	0.8126	0.4629 to 1.1623	0.37	SIGNIFICANT
Railroad 'Way	0.5456	0 to 1.1017	0.72	Not Significant
Oats	0.2179	0.1424 to 0.2934	0.15	Not Significant
Barley	0.2914	0.1567 to 0.4261	0.17	Not Significant
Wheat	0.3160	0.1184 to 0.5136	0.14	Not Significant
Flax	0.1467	0.0759 to 0.2175	0.08	Not Significant
Slough	0.5499	0.3314 to 0.7684	0.30	SIGNIFICANT
TOTAL*	0.2203	0.1817 to 0.2589	0.1678	SIGNIFICANT

*Includes types for which sample size was inadequate and not listed.

estimate fell within the confidence limits of 2581 to 3677 hatched nests. Thus, there was no significant difference in total production between years. It should be noted, however, that the total acreage of nesting cover was 14,203 acres in 1959 and 16,067 in 1958.

Estimates of production for the various cover types are presented for both years in Table 1, and are presented in detail for 1959 in Table 2. During both years grainland ranked first, pastures second, and strip covers third. Over one-fifth of the production was from oat fields, and over one-third from smallgrain. Klonglan (1955) also reported that about one-third of the production was from smallgrain on an Iowa study area. About 60 per cent of the total production in both years of pheasants came from oats, pastures, sloughs, and roadsides.

CLUTCH SIZE

Data on clutch sizes for both years are presented in Table 4. The mean clutch size for hatched nests was 9.2 eggs in 1958 and 8.6 in

TABLE 4. AVERAGE CLUTCH SIZE OF PHEASANT NESTS AND PERCENTAGE HATCHABILITY OF SUCCESSFUL CLUTCHES, SOUTH DAKOTA, 1958 AND 1959

	Successful Nests				Unsuccessful nests		Combined	
	Average clutch size		Percent eggs hatched		Average clutch size		Average clutch size	
Cover Type	1958	1959	1958	1959	1958	1959	1958	1959
Alfalfa (mowed)	8.6	10.8	91.8	82.4	6.4	6.8	6.5	7.1
Red clover	7.0	0.0	100	......	6.2	4.5	6.4	4.5
Legumes (unmowed)	7.5	8.5	92.7	91.5	7.1	8.1	7.2	8.2
SUBTOTAL	7.9	8.8	92.5	90.4	6.5	7.6	6.6	7.8
Tame hay	9.7	9.0	100	94.4	5.3	6.2	7.5	7.2
Wild hay	10.3	6.7	77.4	81.7	6.0	9.9	6.6	8.7
SUBTOTAL	10.1	7.1	84.6	84.6	5.9	9.1	6.7	8.3
Pasture (grazed)	9.2	9.9	95.2	86.3	8.9	7.2	9.0	8.1
Pasture (ungrazed)	9.2	7.5	87.3	93.3	8.7	4.3	8.8	5.6
SUBTOTAL	9.2	9.6	90.0	87.0	8.8	6.9	8.9	7.8
Fencerow	9.9	8.2	71.7	89.8	10.9	9.5	10.8	9.4
Roadside	10.8	9.5	81.0	73.7	9.9	8.5	10.1	8.8
Field margin	7.2	0.0	83.3	......	9.2	9.6	8.9	9.6
Railroad 'way	11.6	8.5	81.5	70.6	0.0	8.7	11.6	8.6
Grassy ditches	0.0	0.0	......	......	0.0	4.0	0.0	4.0
SUBTOTAL	10.4	9.0	79.6	77.8	10.2	9.1	10.2	9.1
Oats	7.9	7.0	90.1	84.9	5.3	5.8	6.3	6.3
Oats (Conservation Reserve)	0.0	3.0	......	66.7	0.0	2.0	0.0	2.5
Barley	8.9	7.4	93.8	89.8	6.1	6.8	6.8	7.1
Wheat	8.0	7.8	97.9	93.6	0.0	5.8	8.0	7.0
SUBTOTAL	8.1	7.1	92.1	87.5	5.6	5.9	6.6	6.4
Treeland	9.0	8.0	100	37.5	11.6	10.6	11.3	10.3
Flax	8.2	7.8	93.3	85.5	5.1	6.4	6.9	6.9
Sloughs	10.8	12.1	73.8	75.2	10.1	9.2	10.2	9.9
Idle farmland	10.6	0.0	97.3	......	9.9	9.0	10.0	9.0
TOTAL	9.2	8.6	85.9	86.9	8.1	7.8	8.3	8.0

TABLE 5. MEAN CLUTCH SIZE OF PHEASANT NESTS[1]

Location	Mean clutch size	Size of sample	Year
California	10.7	60	1947
Iowa	11.2	109	1933-35
Michigan	10.9-11.8	193	1932-33
Minnesota	9.7	73	1942
Ohio	8.6	157	1946
Ohio	8.7	155	1947
Pelee Island	11.7±0.2	607	1949
Pelee Island	11.8±0.2	741	1950
Pennsylvania	10.8	141	1939
South Dakota	9.2	239	1958
South Dakota	8.6	215	1959
Washington	12.6	76	1940-42

[1]From Stokes, 1954—South Dakota data added.

1959. When all nests are considered, the mean clutch size was 8.3 and 8.0 eggs. Hatchability of successful clutches was nearly the same in both years; 86 and 87 per cent. The largest average clutch sizes and earliest nesting were observed in cover types where the greatest amount of residual cover was found. The smallest average clutch sizes were observed in cover types consisting primarily of new vegetation, such as flax, smallgrain, and alfalfa. This reduction in clutch size as a season progresses has been reported by many workers (Dustman, 1950; Seubert, 1952; Stokes, 1954; et al.).

As based upon complete clutches found throughout the nesting season, mean clutch sizes of pheasant nests reported for studies in various areas of the United States have ranged from 8.6 to 12.6 eggs (Stokes, 1954). The mean clutch sizes for the South Dakota study were among the lowest (Table 5).

Brome grass *(Bromus inermis)* and bluegrass *(Poa pratensis)* comprised about 70 per cent of the vegetation at the site of nests. However, no preference for any one species was detected, since plant species occurred at nest sites in the approximate order of their abundance on the study area.

SUMMARY AND CONCLUSIONS

Information on pheasant nesting and brood production in various nesting cover types was obtained through intensive nesting habitat studies in 1958 and 1959, on a township-size area in eastern South Dakota. The study area lies within the State's prime pheasant range in a diversified livestock and corn-grain economy. Pheasant density was 147 birds per square mile in mid-February, 1959, and a population estimated as high or higher occurred in 1958. Pheasant sex ratios were 31 cocks per 100 hens in 1958 and 35 in 1959.

Nine broad categories of vegetation—strip cover, pasture, legumes, small grain, sloughs, flax, hayland, treeland, and idle farmland—were searched and nest histories recorded.

Oats, pasture, flax, and alfalfa were the principal cover types, comprising 75 per cent of the nesting cover in 1958, and 70 per cent in 1959.

Study design included the use of a Latin Square method of randomly sampling eight of the 16, square, 5-acre, quarter-section corner plots in each of the 36 sections in 1958. In 1959, 20 randomly selected 50 by 1000 foot strips per section were searched. In 1958, 6.5 per cent of the nesting habitat was searched and in 1959, 3.6 per cent.

The 1958 sampling design was adequate for determination of nesting densities in most cover types; the 1959 design accurately depicted both nesting density by cover types and the proportions of the cover types on the area. The use of an improved design in 1959 made possible a reduction of about 50 per cent in the acres sampled.

In 1958, 791 nests were found in searching 1051 acres. In 1959, 409 nests were found in 512 acres.

Overall nest density was 0.84 nest per acre in 1958, and 0.91 in 1959. Highest densities were observed in fencerow and roadside strip-cover types, and in field-size blocks of alfalfa and sloughs.

Average hatching success was 20.0 per cent of all nests in 1958, and 24.3 per cent in 1959. The highest success was observed in small-grain, flax, and railroad rights-of-way. Based upon the projected totals of hens and hatched nests on the 36 sections, it is estimated that 88 per cent of all hens succeeded in hatching a clutch in 1959. Hen success data could not be calculated for 1958 for lack of reliable spring population estimate.

There was no significant difference in total production between years. Nearly 70 per cent of the total production of young pheasants in both years came from small grain, pastures, sloughs, and roadsides. Less than average nesting density, but good hatching success was observed in small grain. More young pheasants were produced in small grain than in any other cover type.

The clutch size of hatched nests averaged 9.2 and 8.6 eggs, with 86 and 87 per cent of the eggs hatched each year. Mean clutch size for all nests found was 8.3 and 8.0 eggs. The largest clutches and earliest nesting were observed in cover types where the greatest amount of residual cover occurred. Hatchability was highest for mid- and late-season nests.

No preference for plant species was detected in nest placement. Plant species occurred at nest sites in the approximate order of their abundance within each cover type.

From this study the relative use and value of various nesting cover types for pheasant production has been determined for a portion of the South Dakota pheasant range. The results have been a corroboration of the time-tested management practices of delaying the destruction of cover as long as possible, and new information on the value of certain cover types has been obtained. *On lands devoted to maximum game production,* alfalfa and clover should not be mowed; grasslands should not be grazed or grazed but very lightly; and small grain should be favored over row crops for the provision of cropland nesting cover. The benefits to pheasant production by delaying the mowing of roadsides should be impressed upon public road agencies.

This study is but one phase of an evaluation of pheasant nesting habitat in South Dakota. It is hoped that similar studies can be made in different agricultural land-use areas in the State's prime pheasant range. The information obtained not only provides a basis for management recommendations, but also leads to new avenues for investigations of habitat values, as well as approaches to cover manipulation and design.

LITERATURE CITED

Baskett, T. S.
1941. Production of pheasants in north-central Iowa in 1939. Jour. Wildl. Mgt. 5(2): 168-173.

Dustman, E. H.
1950. Nesting and production of the ring-necked pheasant in northwestern Ohio following a population decline. Unpublished Ph.D. dissertation, Ohio State University, Columbus, Ohio.

Hamerstrom, F. N., Jr.
1936. A study of the nesting habits of the ring-necked pheasant in northwest Iowa. Iowa State Coll. Jour. Sci., 10:2:173-203.

Klonglan, E. D.
1955. Pheasant nesting and production in Winnebago county, Iowa, 1954. Proc. Iowa Acad. Sci., 62:626-637.

Stokes, A. W.
1954. Population studies of the ring-necked pheasant on Pelee Island, Ontario. Ontario Dept. of Lands and Forests, Tech. Bull, Wildlife Series No. 4, 154 pp.

Seubert, J. L.
1952. Observations on the renesting behavior of the ring-necked pheasant. N. Amer. Wildl. Conf. Tran. 17:305-329.

United States Department of Agriculture
1941. Yearbook of Agriculture, Climate and Man. U. S. Gov't. Printing Office, Washington, D. C.

United States Department of Commerce
1958. Weather Bureau, Annual Survey, South Dakota Section. Vol. LXIII. No. 13, Asheville, North Carolina.

AN ANALYSIS OF PHEASANT NESTING IN SOUTH-CENTRAL NEBRASKA[1]

RAYMOND L. LINDER, DAVID L. LYON, AND C. PHILLIP AGEE
Nebraska Game, Forestation and Parks Commission, Lincoln, Nebraska

The ring-necked pheasant (*Phasianus colchicus*) constitutes the most important species of upland game bird in Nebraska. According to Mohler (1960), Nebraska's population is the result of a relatively small introduction; probably not more than 500 pairs were brought into the state between the years 1915 and 1925—the period of initial establishment. Through natural increase and dispersal, aided by a program of trapping and transplanting, a population estimated to be more than one million was reached by 1930 (Swenk, 1930). The statewide population continued an upward trend until the early '40's and then began to decline. Coincident with these changes, there occurred apparent shifts of centers of population from one part of the state to another. It is presumed that these "shifts" consisted of differential changes in the population levels in various regions of the state.

Nebraska, similar to many other states, inaugurated programs intended to increase or stabilize populations. While these efforts did not accomplish the desired results, they attested to the need for factual information upon which management programs might be founded. To be effective, any program of management must be directed at the limiting factor which prevails in the locality.

The primary prerequisite to such a program is a thorough knowledge of the life history of the species to be managed and its ecology in that particular environment. In 1954, an intensive research project was begun for the purpose of gathering such information. This study, entitled "The Life History and Ecology of the Ring-necked Pheasant" (Pittman-Robertson Project W-28-R), is now in its sixth year and is designated to continue until 1964. In this study, we are attempting to examine each segment of the life history and to relate it to environmental influences. One segment being given particular attention is reproduction, for extensive data have suggested that this has been closely related to population fluctuations. It is the purpose of this paper to describe work accomplished to date relative to nesting and to relate this to changes in the population.

The authors are indebted to Dr. J. Henry Sather, former Project Leader, who initiated the research project, to Mr. Max Hamilton and Mr. James A. Norman, biologists who contributed substantially to the

[1]Work conducted under Pittman-Robertson Project W-28-R, "Life History and Ecology of the Ring-necked Pheasant."

study and to the administrators of the Nebraska Game, Forestation and Parks Commission who furnished necessary support to the program. Thanks are also due the many farmer-cooperators who have permitted the use of their farms in this and other parts of the pheasant research program.

DESCRIPTION OF AREA

The Harvard study area occupies seven sections in the northern part of Clay County (elevation 1,800 feet), a region of gently undulating uplands slightly modified by stream erosion. Soil types in this area are largely silt loams belonging to the Crete-Hastings series, with Butler, Fillmore and Scott silt loams occurring in depressions and basin areas. Soil tests taken in Clay County show pH values in these soil types ranging from 5.4 to 8.3 (Roberts and Gemmell, 1927). Soil technicians regard calcium levels to be adequate for all crops except legumes on the most acid sites.

The climate of Clay County is characterized by long, moderately hot summers and cold, dry winters. Mean monthly temperatures range from 25.2° F. in January to 78.9° F. in July. Mean annual precipitation is 22.52 inches, 43 percent of which falls during May, June and July (U. S. Department of Commerce—Weather Bureau, 1957). The average growing season is 155 days long (Roberts and Gemmell, *op. cit.*).

Approximately 95 percent of the study area was intensively cultivated or grazed. Of the total acreage, row crops (corn and grain sorghum) occupied about 45 percent; winter wheat, 25 percent; pasture, nine percent and alfalfa, three percent. Winter barley, oats, sweet clover and native hay were grown on the study area, but only infrequently and usually in small parcels. There was little change in land use during the course of the nesting study, except during 1956 and 1957 when emphasis was temporarily shifted from corn to grain sorghum due to drought. At no time on the area was there land in the Soil Bank program.

Roadsides, fencerows and odd areas occupied less than two percent of the total acreage. The widths of roadsides ranged from five to thirty feet and averaged approximately twenty feet. Width of cover in fencerows, however, was more restricted, ranging from zero to eight feet with an average of only three to four feet. Odd areas were comprised largely of farmsteads and railroad right-of-ways which had been abandoned and had reverted to mixed weedy grasses and forbs.

In general, facilities for deep-well irrigation increased during the course of the nesting study. The acreage under irrigation increased from 14 percent of the study area in 1955 to 23 percent in 1957. This activity was curtailed somewhat in 1958 and 1959 with improved rainfall. Crops irrigated included corn, grain sorghum, alfalfa and wheat. However, each year, corn and sorghum comprised more than 90 percent of the total acres irrigated.

STUDY DESIGN

The primary objective of the nest study was to analyze nesting as a factor in population changes and to evaluate some of the environmental factors which influenced the success of nesting. This involved determining the relative importance of various cover types in production and the role of various agents affecting nesting success.

To facilitate an evaluation of nesting, a method of sampling similar to that of Stokes (1954) was used. By this method, production from each cover type was calculated, using data from a thorough search of a sample of each type.

The rate of sampling was adjusted to the anticipated density of nests in each cover type. Sampling rates, chosen as representative of those during the study, were:

Alfalfa	1 acre out of 6
Roadsides	1 acre out of 6
Fencerows	1 acre out of 6
Odd areas	1 acre out of 6
Pastures	1 acre out of 6
Wheat	1 acre out of 16

Row crops, small-grain stubble and seriously overgrazed pasture were not sampled since normal farming operations and phenology precluded any significant production from these types. Row crops and overgrazed pastures did not offer nesting cover during the nesting season, and stubble was plowed in the spring before chicks had hatched.

The investigations were conducted on a seven-square-mile study area, except the first year when only four sections were sampled. To facilitate comparison, the findings for that year have been projected to seven square miles.

In 1955, plots were selected by placing a grid with numbered squares over the map of each parcel of land of a single cover type. Then, by selecting numbers at random, plots (usually one acre in size) were placed on the maps to correspond with the numbered squares. The number of plots in each parcel depended on the assigned rate of sampling and the size of the unit of cover. This procedure was found to be time consuming, due largely to the difficulty of locating these plots in the field. In subsequent years, transects were used instead of the plots. Each transect was laid out to extend the length of the field; its width was adjusted to cover the desired area (usually one acre). The position of each transect in the field was established by random drawing. Each roadside and fencerow, being of generally linear shape, was divided into six equal segments and one was selected randomly as the plot.

It was necessary to deviate from the predetermined transects only when sampling wheat in 1958 and 1959. The height and density of the ripening wheat those years made it inadvisable to complete the search of plots as planned. An alternate procedure was adopted whereby tractor-drawn combies were followed and the strip free of cut straw was searched as a transect.

Plots were searched once within the period May 15 to June 15 and again between June 15 and July 15 by two permanent personnel with the help of two student assistants. No efforts were made to calculate production from nests established later than July 15. However, brood studies conducted each year indicated at least 97 percent of the chicks to have come from nests established before the completion of the study.

For this study, a form containing one or more eggs was considered to be a nest. All information concerning the nest and eggs was recorded on mimeographed forms. Nests, except those that were destroyed before they were found, were revisited regularly, the observer being careful not to disturb the hen if she was present.

The number of nests found on plots in each cover type was projected according to the rate of sampling to determine the total number of nests in that type. This figure, multiplied by the average number of eggs in all nests found, gave the calculated number of eggs in each type. Production of chicks was calculated by multiplying the percent of eggs successful in each type by the calculated number of eggs in that cover type.

The breeding populations of hens on the area were determined from aerial and ground counts made during January and February and sex ratio counts obtained by flushing birds from concentrations during late winter storms. Only resident wild hens were present on the area during the study except in 1956 when 250 pen-reared hens were released at the beginning of the nesting season.

In order to evaluate efficiency of searching sample plots, 32 dummy nests were secretly placed on plots in various cover types in 1958. Thirty or 94 percent of these were found by the searchers. Further evidence of efficiency is found in the fact that during the five years only two nests found during the second search had been missed in the first search.

As a part of the records, notes were kept regarding possible influence of the investigators upon nesting success. During the course of the study, only 29 hens were flushed from the nests, and of these, 20 returned. Two nests were accidentally destroyed by the searchers.

RESULTS

The breeding population of pheasants on the study area averaged 29 birds per section. This is relatively low compared with the population levels cited in other nesting studies: breeding populations of 50 to 125 birds per section in north-central Iowa (Baskett, 1947), 78 birds per section in Pennsylvania (Randall, 1940), and 608 nesting hens per section on Pelee Island, Ontario (Stokes, 1954).

The average number of resident hens on the seven-section study area was 144, with a range of 115 to 212 (Table 1). The sex ratio averaged 42 cocks per 100 hens, the extremes being 29 in 1959 and 67 in 1955.

During the five years, 622 nests were found on the study area. Two hundred sixty of these were on plots and served as a base from which the total number of nests in the various cover types were calculated. The greatest numbers of nests were in wheat which contained 38.4 percent, alfalfa which had 27.5 percent and roadsides which had 23.6 percent of the nests (Table 2).

Fencerows, odd areas and pastures were of little importance for nesting on the study area; only 10.5 percent of the nests occurred in these cover types. Except in 1959, pastures were not used for nesting, reflecting the sparse cover conditions brought about by low precipitation and overgrazing.

Based upon the several nesting studies reported in the literature, there is little uniformity in the use of a given cover type for nesting in the different parts of the pheasant range and in the rates of success of those nests. For instance, in hayfields the percent of nests varied

TABLE 1. SPRING POPULATIONS OF HENS AND RESULTANT PRODUCTION

	Year					
	1955	1956	1957	1958	1959	Average
Spring population of hens	124	365*	124	145	212	144
Nests:						
Found on plots	23	47	41	46	103	52
Total found	151	109	68	174	120	124
On study area (calculated)	264	400	267	383	768	416
Eggs:						
On study area (calculated)	2,510	2,997	2,428	3,141	5,392	3,294
Percent successful	13.1	13.6	19.9	20.6	11.4	15.1
Chicks produced (calculated)	329	407	483	648	614	496

*Includes 115 wild resident hens and 250 pen-reared hens.

TABLE 2. NESTING AND PRODUCTION BY YEAR AND BY COVER TYPE

	1955	1956	1957	1958	1959	Average
Number of nests in:						(Percent of all nests)
Alfalfa	34	32	74	156	276	27.5
Wheat	112	176	105	137	270	38.4
Roadsides	96	162	77	54	102	23.6
Pastures	0	0	0	0	84	4.0
Fencerows	22	12	4	12	18	3.3
Odd areas	0	18	7	24	18	3.2
All types	264	400	267	383	768	100.0
Percent success of nests in:						
Alfalfa	0.0	0.0	4.7	3.8	4.3	3.8
Wheat	27.2	9.1	16.6	40.0	20.0	24.8
Roadsides	13.7	22.2	45.4	22.2	11.8	19.3
Pastures	0.0	0.0	0.0	0.0	7.1	7.1
Fencerows	0.0	0.0	0.0	0.0	0.0	0.0
Odd areas	0.0	0.0	0.0	25.0	0.0	5.0
All types	16.2	12.9	21.1	20.6	10.9	15.1
Number of chicks produced in:						
Alfalfa	0	0	29	61	74	33
Wheat	238	146	141	448	385	271
Roadsides	92	261	313	88	104	172
Pastures	0	0	0	0	51	10
Fencerows	0	0	0	0	0	0
Odd areas	0	0	0	51	0	10
Total	329	407	483	648	614	496

from 81.8 percent (Wight, 1949), to 61.6 percent (Leedy and Dustman, 1947), to 4.4 percent (Stokes, 1954), and success of nests from 4.8 percent (Klonglan, 1955), to 45.5 percent (Eklund, 1942).

In the present study, it was found that through the five years, nests were established in the various cover types as follows:

Roadsides — One nest per each 0.6 acres
Fencerows — One nest per each 0.8 acres
Alfalfa — One nest per each 1.3 acres
Odd Areas — One nest per each 1.4 acres
Wheat — One nest per each 6.7 acres
Pastures — One nest per each 13.0 acres

The proportion of nests in each cover type except alfalfa remained fairly constant each year. During the dry years of 1955 and 1956 when the growth of alfalfa was retarded, density of nests in this cover type was low.

Of the total nests established, 37.2 percent were destroyed by farming operations, including 22.2 percent by alfalfa-mowing operations. Alfalfa mowing also resulted in the death or injury of 98 hens. This represented 14 percent of the spring populations of hens during the five years.

Predators destroyed 25.7 percent of the nests. Mammals were of greatest importance, destroying 23.1 percent, while birds took 1.7 percent, and undetermined predators, 0.9 percent. Mammals thought to be most important in destruction of nests were the striped skunk *(M. mephitis)*, little spotted skunk *(Spilogale interruptus)*, opossum (*Didelphis virginiana*), badger (*Taxidea taxus*) and feral house cat *(Felis domesticus)*.

Further loss of nests was attributed to abandonment, which accounted for 12.1 percent of the total number; flooding, which destroyed 1.7 percent; and undetermined causes, which took 8.4 percent.

Most other studies have also shown mowing and predation the principal factors in nest destruction. However, Stokes (1954) found abandonment to be of greater importance than either of these.

The over-all success of nests was lower than most of those reported in other studies. Reports vary from 17.3 percent (Klonglan, 1955) to 51.7 percent (Knott, *et. al.*, 1943). Other writers indicate the rate of success of nests to be 23 and 36 percent (Baskett, 1947), 23.1 percent (Hamerstrom, 1936), 41.8 percent (Westerskov, 1956) and 44.8 percent (Eklund, 1942). In the present study, of all nests established over the five-year period, 15.1 percent produced young. Success was greatest in 1957, when 21.1 percent hatched, and lowest in 1959 when 10.9 percent hatched (Table 2). Success of nests was highest in wheat where 24.8 percent were successful (range: 9.1 to 40.0 percent) and in roadsides where 19.3 percent succeeded (range: 11.8 to 45.4 percent). Rates of success were much lower in other cover types: 7.1 percent in pasture, 5.0 percent in odd areas, 3.8 percent in alfalfa and 0.0 percent in fencerows.

The number of eggs found in all nests averaged 8.0 and ranged from 7.0 eggs per nest in 1959 to 9.5 in 1955. The average number of eggs in incubated nests for the five years was 9.9 with a range from 8.0 in 1959 to 12.1 in 1957. A total of 314 nests was ultimately successful. Of the 781 eggs in 72 of these, 77 percent hatched, 13 percent contained dead embryos, seven percent showed no development and three percent were unclassified. At least 90 percent of these were fertile, based on the presence of an embryo.

Approximately 90 percent of the chicks were produced in wheat and roadsides (Table 2). Even though nest densities were low in wheat, about 55 percent of all the chicks were produced there, reflecting the large area devoted to this crop and the large portion of the nests which succeeded. Roadsides, while comprising less than 1.5 percent of the total acreage, accounted for about 35 percent of all chicks produced, reflecting the high density of nests and rate of success. While densities of nests in alfalfa were high, few chicks were produced there since most of the nests were destroyed. Fencerows and odd areas were unimportant in the production of chicks because of the small acreages devoted to these types and the high loss of nests to predators. During the first four years of the nesting study, no chicks were produced in pastures. However, in 1959, following rains which tended to relieve the over-grazed condition, about eight percent of the chicks were produced in this cover type.

Many investigators have found small-grain fields to be of importance in the production of chicks. As in the present study, Randall (1940) in Pennsylvania found that a large part of the pheasant crop was produced in wheat. During a three-year period in north-central Iowa, Baskett (1947) found that approximately 33 percent of the successful nests were in small grains, and of these, 94 percent were in oats. On the same study area, Klonglan (1955) found 32 percent of the successful nests were in small grains, all of which were in oats. Similarly, Robertson (1958) reported broods produced in oats "may have contributed substantially to total production" in Illinois' pheasant range.

As in the present study, Klonglan *(op. cit.)* in Iowa found roadsides important in the production of chicks. He reported that 29 percent of the successful nests were in this cover type. In eastern Michigan, Shick (1952) reported that the majority of the production of chicks occurred in roadsides and ditchbanks. Also, on Pelee Island (Stokes, 1954), from 43 to 56 percent of the chicks were produced in "Scrub I," which classification apparently included roadsides.

The ranges in the percent of hens successful and the number of chicks per hen recorded in the present study are comparable to similar information as calculated from studies in north-central Iowa (Baskett, 1947 and Klonglan, 1955) and Pennsylvania (Randall, 1940). However, on Pelee Island (Stokes, 1954), the percent of hens successful and the number of chicks per hen were much higher. Similarly, Errington and Hamerstrom (1937) indicated "from 70 to 80 percent of the hens finally succeed in bringing off broods".

Based upon the five-year study reported here, in a hypothetical "average year" 144 hens were present in the breeding population. They established an average of 2.9 nests (23 eggs) each and 63 (44 percent) of the hens succeeded in producing young. The average hatch was 7.8 chicks, making a total of 496 young produced. Based upon the entire population of hens, 3.4 chicks were produced per each hen (Table 3).

DISCUSSION

From examination of the literature, it is evident that much information has been gathered relative to the success of observed nests

TABLE 3. NESTING AND HATCHING ON THE STUDY AREA—1955-1959 INCLUSIVE

Year	Spring population of hens	Number of nests			Percent of hens successful	Number of chicks		
		Per hen	Total	Successful		Total	Per successful hen	Per hen
1955	124	2.1	264	43	34	329	7.7	2.7
1956	115[1]	3.5	400	52	45	407	7.8	3.5
1957	124	2.1	267	56	45	483	8.6	3.9
1958	145	2.7	383	79	54	648	8.2	4.5
1959	212	3.6	768	84	40	614	7.3	2.9
Average	144	2.9	416	63	44	496	7.8	3.4

[1]Excluding 250 game-farm hens.

and the use of various cover types for nesting. However, no studies have dealt with chick production in relation to the spring populations over a period of years. In the present study, because data were obtained over a five-year period and the number of hens in the spring population was known each year, we have attempted to fill a few gaps necessary for a more nearly thorough understanding of productivity and population changes of the pheasant.

USE OF COVER TYPES

In this area, a large part of the total production occurred in winter wheat even though nest densities were low. Since few nests were lost to predation and to harvesting operations, nesting success was high. Of the nests established in wheat, most had hatched before combining operations began which was usually in the first half of July. Furthermore, hens which still were incubating usually returned to the nests after harvesting was completed. Destruction of nests by predators was relatively low, suggesting that the large wheat fields were less intensively explored by mammals than were other cover types which occurred in smaller acreages. This is probably due to the large size of the fields and also to the fields' being plowed each year, not permitting mammals to establish permanent dens.

Roadsides comprised less than 1.5 percent of the total acreage of the study area, but during the five years 23.6 percent of the total nests were established there. One of the reasons roadsides assumed this importance was the presence of cover remaining from the previous year which was available for early nesting. The use of roadsides for nesting, however, varied from year to year, depending upon changes in the quantity and quality of this residual cover. These changes were not synchronized with changes in most other cover types for early cover in roadsides was greatest following dry years. In dry years, fireweed (*Kochia* sp.) became abundant and during the fall and winter was blown into roadside ditches. This additional cover resulted in greater density of nests as well as higher rate of success of those nests. The increased success was not thought to have resulted from improved concealment but from the fireweeds' serving as a deterrent to mammalian predators that normally used roadsides as travel lanes.

Although few chicks were produced in alfalfa, because of the large number of nests established there it was considered one of the most important cover types for nesting. However, as a result of the variations in growth of alfalfa during the five years, the number of nests there fluctuated disproportionately in relation to the total number in all cover types. In 1955 and 1956, both dry years, only 10 percent of the total nests were in alfalfa, while in 1957, 1958 and 1959, years of normal or above normal precipitation, 36 percent of the nests were established there. In the former instance only permanent cover in roadsides, fencerows and odd areas was available early in the season, but in the latter, alfalfa developed quickly and constituted additional early nesting cover. The earlier growth of alfalfa was not, however, followed by earlier mowing; hence, it was useable for a longer period. The result was a higher proportion of nests in alfalfa during wet years and an increase in the percent of nests successful in this cover type.

During nest searching, we were impressed by the small number of chicks killed in alfalfa by mowers. As indicated earlier, few chicks were hatched in alfalfa, and of additional importance is the observation that other cover types, especially wheat, provided preferred roosting and loafing cover as well as an adequate food supply. Consequently, chicks produced in alfalfa probably left soon after hatching and thus escaped the mower.

Odd areas, fencerows and pastures were not important in production; most nests were destroyed by mammalian predators. All three cover types offered sites for permanent dens, and fencerows, where all nests were destroyed, were used as travel lanes as well. Also, in pastures, trampling of nests by livestock created still another hazard.

RENESTING

The ability of hen pheasants to renest is well known, but the extent to which this occurs has probably been underestimated. In this study, we found not only extensive renesting, but also considerable variation between years in the tendency of hens to renest. It is interesting to note that the number of nests established per hen increased as the population was rising. (This is similar to the findings of Kozicky and Hendrickson (1951) who reported the greatest number of "observed" nests per hen on the Winnebago Research Area in Iowa occurred "during the greatest observed spring density for the five-year period".) In 1955 and 1957, the numbers of hens and of nests per hen were the lowest recorded. In 1958, as the population began to rise, there was a corresponding increase in the number of nests per hen, and in 1959, when the population of hens was highest, the greatest number of nests per hen was recorded. This comparison was made for only four years' data. A correlation for 1956 was not possible due to the presence of pen-reared hens.

If we consider that the number of nestings is indicative of the effort exerted by the hen, the above observation appears to be contradictory to the principle of inversity (Errington, 1945). It seems more plausible, however, that the two are entirely compatible. Even though the number of nests per hen increased as the population increased, the average number of eggs per nest declined, and the total *number of eggs* laid by each hen each year remained surprisingly constant. This suggests that the larger number of nests reflected a greater incidence of voluntary abandonments or "false starts" (similar to randomly dropped eggs), which the hen made no attempt to incubate. Hence, it appears that in years of higher population there was more *nesting effort,* about equal *laying effort* and less *incubation effort.*

Whatever the interpretation above, it is apparent that there are weaknesses inherent in any study which relies upon success of nests alone to evaluate production. Since it appears that nesting effort may show considerable variation between years, one must consider nest success in association with spring populations and the number of nests established per hen.

PRODUCTION AND POPULATION LEVELS

During the five years, the primary factor responsible for variations in the rate of production of chicks was the percent of hens bringing off broods and not variation in clutch size and fertility and hatchability of eggs. In 1955, 34 percent of the hens were successful, resulting in production at the rate of 2.7 chicks per each hen in the spring population while in 1958, 54 percent of the hens were successful and the production index was 4.5 chicks per hen. This relationship was consistent throughout the five years, indicating that the percent of hens bringing off broods was the variant directly related to the resultant level of production (Figure 1). However, a secondary factor, the average number of chicks hatched from each successful nest (chicks per successful hen), also influenced production, but the magnitude of the fluctuations in this factor was small. In 1957, the year in which the number of chicks per successful hen deviated

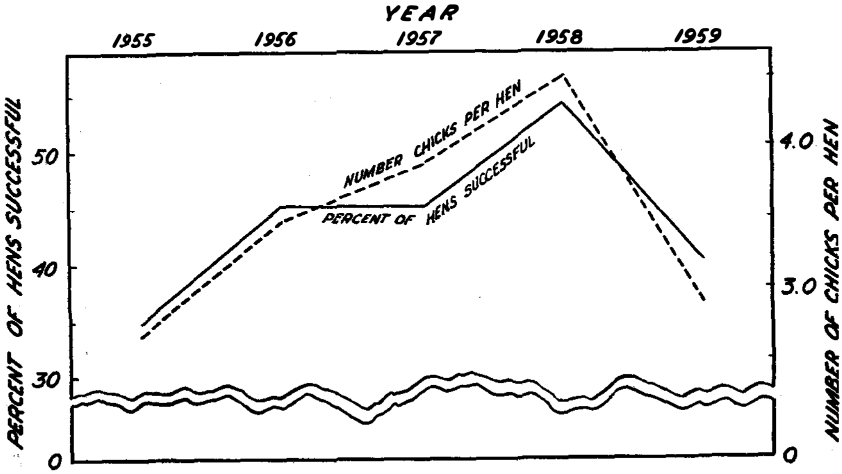

Figure 1. Correlation between percent of hens successful and rate of production.

furthest from the average, only 11.4 percent more chicks were produced per hen than in 1956, even though the percent of hens successful was the same each year (Table 3).

From information gathered during this study, it is evident that chick production was the factor determining changes in the following year's spring population. This correlation is shown in Figure 2. Since there is close correlation between these two factors, annual mortality was evidently quite constant from year to year. In view of this, it is interesting to note that in years when fewer than 3.0 chicks were produced per hen, the following spring's population of hens declined and when the number of chicks produced exceeded 3.0, an increase followed. Evidently, about 3.0 birds for each hen in the breeding population is necessary in order to maintain a constant population level. This correlation was observed also on another study area (Clay Center) about nine miles away. There also, the threshhold was 3.0 chicks per hen. It is interesting to note that the density of birds there was approximately twice that on the present study area. Therefore, since 3.0 chicks was the threshhold on both areas, it is evident that the rate of production was not the factor responsible for the lower population on the Harvard study area.

In 1956, even though the 250 pen-reared hens released on the study area increased the population of hens by about 200 percent over the 1955 hen population, the production of chicks was only 25 percent greater. The fact that these additional hens raised total production very little might be explained in two ways: (1) The pen-reared birds

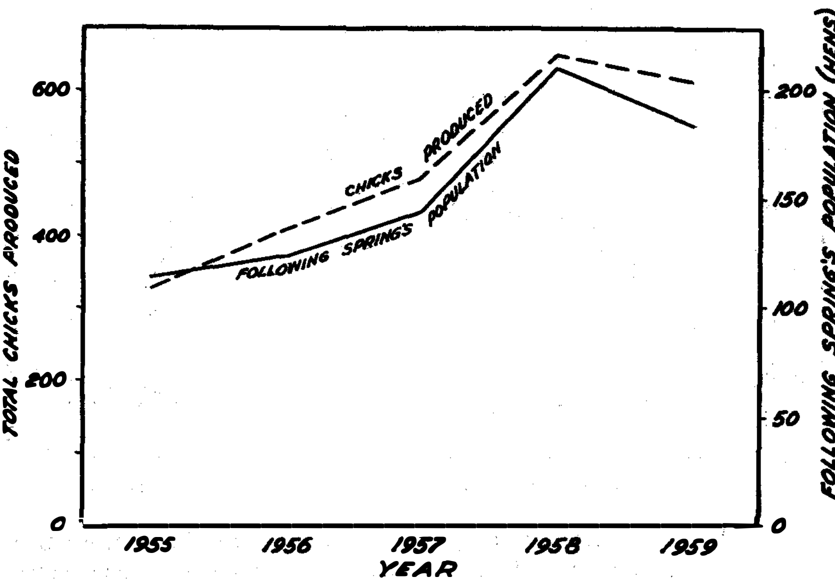

Figure 2. Relationship of number of chicks produced to following spring's population of hens.

were not capable of reproduction under "wild" conditions (2) The quality of the environment during the nesting season proved to be a limiting factor, and determined the upper limit of production regardless of the level of the breeding population. The first seems doubtful since the number of nests established that year exceeded the number for the previous year by 51 percent, suggesting that nests of pen-reared birds supplemented substantially those established by wild resident hens. The second seems more plausible since, despite the increase in the number of nests established, the level of production was approximately that expected from the wild resident hens (Figure 3).

This explanation appears to apply for 1956 and for the other four years as well. It was especially striking in 1959 (Figure 3). In that year a 46-percent increase in the population of hens resulted in a 101-percent increase in the number of nests established; the number of nests successful, however, increased only six percent.

This phenomenon appeared to operate on the Clay Center area as well, but there the number of nests that were successful was approximately twice that on the Harvard area. Rates of production and mortality were about the same on both areas, and thus the populations fluctuated simultaneously but at different levels.

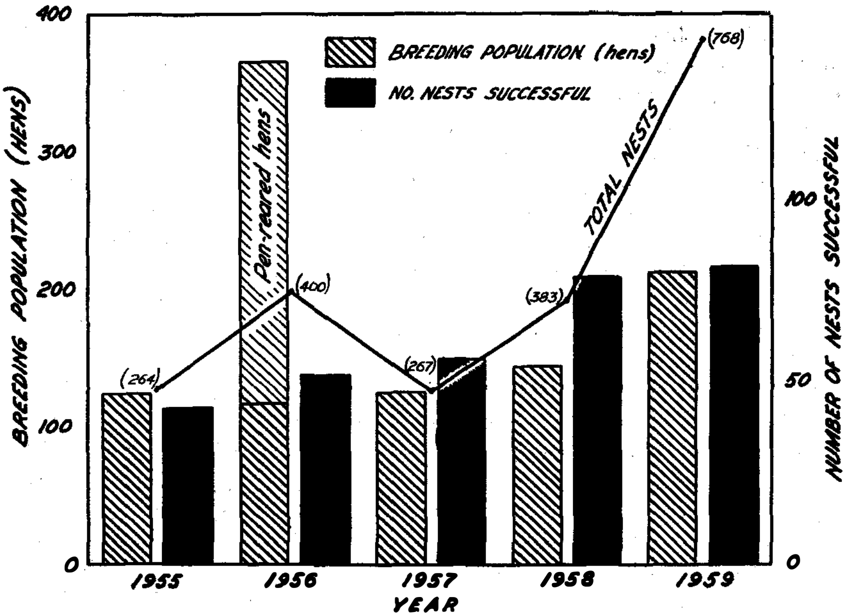

Figure 3. Relationship between number of breeding hens and number of nests successful.

In the light of this interpretation, 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. In each of the five years, a surplus of hens was present in the breeding population.

SUMMARY AND CONCLUSIONS

A nesting study was conducted on the Harvard Study area in south-central Nebraska from 1955-1959. Objectives were to evaluate the importance of various cover types in the production of chicks and the role of chick production in relation to changes in population.

The average breeding population of hens was 144, as determined from aerial and ground counts.

During the five years, 622 nests were found, 260 of them on sample plots. The number of nests on plots was projected to determine the total number established in each cover type.

Information was presented and discussed concerning success of nests, density of nests, and production of chicks in each cover type.

Nearly 90 percent of the nests on the area were located in wheat, roadsides, and alfalfa; about 90 percent of the total production of chicks came from nests in wheat and roadsides.

In a hypothetical "average year" 144 hens established an average of 2.9 nests each. Sixty-three (44 percent) of the hens produced young, and 7.8 chicks hatched from each successful nest. An average of 496 chicks or 3.4 chicks per hen (based upon the entire breeding population) was produced each year.

Extensive renesting occurred on the study area. Of more interest, however, was the greater incidence in renesting during years of population increase. Some aspects of this phenomenon in relation to the principle of inversity, were discussed.

The percent of hens successful in producing young was the factor most closely related to the fluctuations in the rate of production of chicks from year to year.

Throughout the study, each year's breeding population correlated closely with the preceding year's production and the average number of chicks produced for each hen seemed to offer a key to predicting increases or decreases in the following springs' populations. A production index of 3.0 young per hen seemed to represent a threshhold; when this figure was not attained, the following spring's population declined and when exceeded, the breeding population increased.

Based upon the data gathered, the quality of the nesting environment appeared to determine the *number* of nests which would be successful in a given year; this regulated production which in turn determined the level of the following year's breeding population. In each of the five years, a surplus of hens was apparently present in the breeding population.

LITERATURE CITED

Baskett, Thomas S.
1947. Nesting and production of the ring-necked pheasant in north-central Iowa. Ecol. Monog. 17:1-30.

Eklund, Carl R.
1942. Ecological and mortality factors affecting the nesting of the Chinese pheasant in Willamette Valley, Oregon. Jour. Wildl. Mgt. 6(3):225-230.

Errington, Paul L.
1945. Some contributions of a fifteen-year local study of the northern bobwhite to a knowledge of population phenomena. Ecol. Monog. 15:1-34.

Errington, Paul L. and F. N. Hamerstrom, Jr.
1937. The evaluation of nesting losses and juvenile mortality of the ring-necked pheasant. Jour. Wildl. Mgt. 1 (1 & 2):3-20.

Hamerstrom, F. N., Jr.
1936. A study of the nesting habits of the ring-necked pheasant in northwest Iowa. Iowa State Coll. Jour. Sci. 10(2):173-203.

Klonglan, Eugene D.
1955. Pheasant nesting and production in Winnebago county, Iowa. 1954. Proc. Iowa Acad. Sci. 62:626-637.

Knott, Norman P., Chester C. Ball and Charles F. Yocum
1943. Nesting of the Hungarian partridge and ring-necked pheasant in Whitman county, Washington. Jour. Wildl. Mgt. 7(3):283-291.

Kozicky, E. L. and G. O. Hendrickson
1951. The production of ring-necked pheasants in Winnebago County, Iowa. Proc. Iowa Acad. Sci. 58:491-495.

Leedy, Daniel L. and Eugene H. Dustman
1947. The pheasant decline and land-use trends, 1941-1946. Trans. N. Amer. Wildl. Conf. 12:479-490.

Mohler, Levi L.
1960. Investigations of the pheasant in Nebraska, 1941-1952. Nebraska Game, Forestation, and Parks Comm. Tech. Bull. 150 pp.

Randall, Pierce E.
1940. The life equation of the ring-necked pheasant in Pennsylvania. Trans. N. Amer. Wildl. Conf. 5:300-320.
Roberts, R. C., and Ralph Gemmel
1927. Soil survey of Clay county, Nebraska. U. S. Dept. Agr. Series 1927, No. 8. 28 pp.
Robertson, William B.
1958. Investigations of ring-necked pheasants in Ilinois. Ill. Dept. Cons., Tech. Bull. No. 1. 137 pp.
Shick, Charles
1952. A study of pheasants on the 9,000-acre Prairie Farm, Saginaw county, Michigan. Mich. Dept. Cons. 134 pp.
Stokes, Allen W.
1954. Population studies of the ring-necked pheasant on Pelee Island, Ontario. Ontario Dept. of Lands and Forests, Tech. Bull., Wildlife Series No. 4, 154 pp.
Swenk, Myron H.
1930. The food habits of the ring-necked pheasant in central Nebraska. Univ. of Nebr. Agr. Exp. Sta., Res. Bull. 50. 33 pp.
U. S. Dept. of Commerce-Weather Bureau
1957. Mean temperature and precipitation—Nebraska (multicopy).
Westerskov, Kaj
1956. Productivity of New Zealand pheasant populations. New Zealand Dept. Internal Affairs, Wildl. Publ. No. 40B. 144 pp.
Wight, H. M.
1949. Nesting loss—the pheasant bottleneck. Penn. Agr. Exp. Sta. Paper 1937, Jour. Series.

DISCUSSION

MR. THOMAS A. SCHRADER [Falls Church, Va.]: I am curious, and I would like to ask both of these men the same question. I don't know the percentage of the crop land which has been placed in the soil bank in the county in Nebraska in which these studies were made, but in Brookings County, if my memory serves me correctly, something in the neighborhood of 8 per cent of the crop land was in the conservation reserve in 1959. Did you not make any surveys in soil bank land, or are they included in one of these categories?

MR. TRAUTMAN: The first studies from the soil bank were in the year of 1958. That was a 37-acre field. This year in 1959 there were approximately, I would say, 120 acres, but that, of course, was the first year. Actually, it was just the establishment of oats or the small grain crop with the seeding of the more or less perennial vegetation, but that 37-acre field was the only conservation reserve lands on the area.

I might add, since you obviously are interested in the Soil Bank, Tom, this other survey involved a study of 21 fields of each. The average for the entire acreage was 2.5 nests per acre, which compares to the ordinary alfalfa of the two years. That is, 1958 and 1959 1.3 and 1.6 nests per acre, so it obviously is attractive.

The only difficulty was that we had some that we didn't know the exact age of. That, of course, is very important in conservation reserve land.

MR. LINDER: On our study area during the five years we had no soil bank land on the seven sections.

DR. GEORGE A. PETRIDES: [East Lansing, Mich.]: This isn't a question. It struck me as the last paper was read that the turnover rates in the pheasant population is 75 per cent on the average, and this directly parallels the population turnover study results which Dr. Rinebole and his students found in the arboretum at Madison. This may be evidence which these gentlemen wish to use if the 75 per cent figure is to be considered a critical level.

DISCUSSION LEADER DUSTMAN: In view of the pheasant scare which we had in many parts of the Midwest, I thought there would be many questions asked regarding the high rate of production in the area and the general decrease in the pheasant population this past season. I wonder if Mr. Trautman would care to comment on the high rate of production on his study area?

MR. TRAUTMAN: The production, of course, as we found out after the work was done and the reports were in, indicated rather spotty reproduction throughout the state. There was very good correlation between our hay and crop production and our area of poor reproduction within the state.

The particular area that we were in of course, was not in this particular production slump. That followed through from Nebraska upwards through the southeastern part of the state and up along the eastern. I don't know to what extent western Minnesota felt it, but there was a good correlation between drought and the agricultural deficiency with poor reproduction.

We need additional information on that, but for this particular area, to answer Dusty's question, the August brood counts were just slightly up, about 9 per cent, and the subsequent age range that was in the hunter bag was at least normal to possibly slightly above that which generally we consider a normal range.

We did get area information under relatively poor conditions, and the February count in 1959 was 141 birds per square mile on a part of this area that I counted under relatively poor conditions. We had greater harvest, so I believe we anticipate we have about the same status of population, about the same level as we had last year.

MR. LINDER: I thought I might as well tell you what the Nebraska pheasant population was while I am up here. Production this past year, chicks per hen was about average for the past ten years, considerably lower than 1958, but we had a substantial increase in the breeding population state-wide last spring in some regions of the state, the southwestern part as much as about 100 per cent increase, and so this fall we had more birds than in 1958; production was down sharply from 1958, but it was about average for the past ten years. 1958 was an exceptionally good year for reproduction.

MR. TRAUTMAN: Excuse me for interrupting, but I did want to point out one thing. We had two different sampling systems in effect, and the efficiency of the 50x1000 acre plots, the location of nests and so forth was greater, possibly the percentage as differences were slightly, in spite of that. The 5-acre plots were more cumbersome. It took a greater detail, greater efforts to locate and find all the nests. Possibly some nests were missed in those larger sample plots of the previous year.

MR. LES BERNER [Game and Fish, Pierre, S.D.]: Mr. Linder, didn't you say you had a surplus of hens each year? Why don't you put a hen in the bag?

MR. LINDER: I didn't say we had a surplus of hens each year. I said "for the 5 years of study." We probably do each year. Why don't we have one in the bag? I think we should. I know a lot of people won't agree with me. It's just a matter of trying to regulate as far as I am concerned.

MR. CHARLES V. BOHART [Lincoln, Nebr.]: I would like to ask in relation to the studies made, are either of the gentlemen in a position to make a recommendation as to the species of grasses and perhaps some other plants that might be used in developing better roadside or field plantings, perhaps in soil bank land, to make better nesting?

MR. LINDER: To me the most important thing probably for roadside or anywhere else is to carry over cover from the previous year. Our roadsides as they stand probably would be hard to improve because they are not mowed. They are burned once in a while, often enough to keep them in a constant fluctuation of cover, but most of them are in forbs or revert to native grasses. Western wheat grass is fairly important.

The residual cover from the previous year is the important thing, and the same thing would hold true in an area where there is high nest loss from mowing. Cover from the previous year is available earlier than the alfalfa. If possible, leave cover from the previous year, be it a grass that stands through the winter such as Western wheat grass or, better yet, fire weed.

WATER REQUIREMENTS OF GAMBEL'S QUAIL[1]

CHARLES R. HUNGERFORD
University of Arizona, Tucson, Arizona

In 1942 California installed the first watering devices for upland game birds. These have become known as the "Glading's gallinaceous guzzlers" (MacGregor, 1953). With various improvements and modifications, this type of water source has been adopted and installed in increasing numbers by many western states. The majority of these rainwater catchments are constructed to provide drinking water for Gambel's, scaled, California, and other western quails living in arid and semi-arid locations. These birds have been observed to use the water provided, and there is no longer doubt that properly designed rainwater catchments are physically capable of providing open water during dry periods.

Present-day management of western quail apparently relies quite heavily on artificial storage of water, and it is perhaps the most common form of habitat improvement now practiced in many states. In this period of increased water development for quail it is interesting to compare the opinions expressed by earlier authors on the water requirements of western quails. Leopold (1933), Vorhies (1928) and Gorsuch (1934) were convinced from their field observations that Gambel's quail of all ages can subsist without open water by feeding on berries, leaves and other succulent parts of plants. Russell (1932) studied the life history of scaled quail in New Mexico and concluded that these quail do not require drinking water. Sumner (1935) reported normal activity and breeding of California quail kept in a large enclosure without water for one full year.

Recent studies during this period of catchment construction by Wallmo (1956) did not find a complete dependence of scaled quail on open water sources, and Lowe (1955) found Gambel's quail living on arid Tiburon Island in the Gulf of California, a distance of nine miles from any source of fresh water.

Campbell (1960) evaluated the economic feasibility as well as the management results of water catchment construction in New Mexico. On the basis of the meager quail use of these catchments, he considered them neither sufficiently effective to be practical nor economically justified in New Mexico quail management. Other investigators, however, in California (MacGregor, 1953), Nevada (Gullion, 1958), and Arizona (Wright, 1953, 1959; Webb, 1958) studied the

[1]This study is a contribution of the Arizona Cooperative Wildlife Research Unit: The U. S. Fish and Wildlife Service, the Arizona Game and Fish Department, the University of Arizona and the Wildlife Management Institute cooperating.

importance of rainwater catchments and concluded that they are beneficial and economically justified. All of these studies, including Campbell's, based the importance of catchments on the amount of use they received and on the increase in total population near these water developments.

These disagreements in the results of current studies as well as variance with the findings of earlier biologists motivated the research reported in this paper. An alternate method was sought to determine whether or not wild Gambel's quail are capable of surviving without free water during the dry seasons in southern Arizona.

METHODS

Gambel's quail were studied in three basic habitat divisions in southern Arizona. Three large study areas were selected, one in desert-shrub, one in desert-grassland, and one in chaparral. The range of Gambel's quail in southern Arizona extends from near 100 feet in elevation in saguaro cactus *(Carnegiea gigantea)* and paloverde *(Cercidium microphyllum)* up to 4800 feet or higher in liveoaks *(Quercus Emoryi, Q. oblongifolia)* and manzanita *(Arctostaphylos Pringlei)*. The moisture requirements of Gambel's quail and their reliance on succulent foods was one objective of an investigation of factors influencing quail production (Hungerford, 1960).

The daily and seasonal movements of individual quail coveys in relation to available open water was observed. All water holes on the three study areas were found by ground and aerial inspection and the location of coveys in relation to these water sources was checked frequently during the dry seasons. Field observations and data were gathered from 1954 through 1957. A total of 221 crops were analyzed for seasonal food consumption; the moisture content of these crops was also determined. Multiple samples of thirty-four quail food plants were collected at different seasons and the moisture present in leaves, flowers, fruit, and other edible parts was measured. Succulent parts of food plants were collected, weighed, and dried at 100° C. for 24 hours and the resulting weight loss converted to percent moisture.

Field observations of use or non-use of open water were considered too empirical to evaluate adequately the basic need of quail for water. Special adaptations in physiology or behavior might well be part of this bird's ability to survive in deserts. Leopold and Vorhies (op.cit.) considered it possible that Gambel's quail are able to obtain adequate water from their native foods. To ascertain whether adequate moisture was ingested in the food, an approximation of both the daily requirement of food and the total water requirement of Gambel's quail was needed. No reference was found citing Gambel's quail food requirements, but Sumner (op.cit.) determined the weight of food eaten daily by California quail using a method that has been adopted by more recent authors. This procedure is based on the daily change in body weight of wild-trapped birds. Although admittedly an estimate, the results are believed to be as accurate as food consumption figures obtained under the artificial conditions of pen experiments. Based on a sample of 108 birds taken from September to December, Sumner found the daily food intake to be 14.3 percent of body weight. This calculated daily requirement for California quail was used in the present study as approximating the normal food intake of non-laying Gambel's quail.

No published figures on water consumption of wild quail were found. There are, however, a few references which give the daily water consumption at certain temperatures of other desert-dwelling birds including the mourning dove (Bartholomew and Dawson, 1954). By assuming that the dove has an equal or higher water requirement, the moisture requirement of Gambel's quail can be approximated. Mourning doves consumed 6.5 percent of their body weight daily when water was before them continuously and air temperatures were kept at a uniform 74.5° F. Water consumption of doves apparently is related to air temperature. Gambel's quail should drink no more than this percentage of their body weight daily in the wild under similar average temperatures. The month of May in Arizona is hot and dry, but the mean temperature approaches that of these experimental conditions (73.2° F. at Tucson, Arizona).

RESULTS

The average weight of non-laying adult quail collected during the present study at all seasons averaged 164 grams. Quail with free access to water might consume 10.7 grams of water per day in May if basic water consumption of Gambel's quail was similar to that of the mourning dove. Sumner (op.cit.) found California quail consumed 14.3 percent of their body weight in food daily. Gambel's quail of similar size and habits would then consume approximately 23 grams of food per day. This assumption seems reasonable since full crops representing food intake for half of the daily feeding period contained 10 to 17 grams of food. To provide 10.7 grams of moisture per day, the food would have to contain 46.5 percent moisture. Thus, it might be possible that this desert species can maintain a water balance by consuming foods with at least 50 percent moisture. Field observations made during this study support this possibility.

Gambel's quail were observed to raise young and survive even the driest season in drouth years, apparently relying entirely on moisture derived from vegetation. In the summers of both 1955 and 1956 adult coveys or pairs with broods were seen at least three-quarters of a mile from open water in all three study areas. These same coveys were found in essentially the same locations in repeated observations made at one-day to two-week intervals. The groups could be identified by the size and number of young and the total number of individuals. The available open water was checked during these same periods and was found to be used only by the coveys ranging nearby. Daily movements of the quail apparently decreased instead of increased during these hot, dry periods, and adult and young quail were attracted to open water only if it was near or in their daily range of movement.

A high proportion of the diet of these desert quail consists of succulent foods (Table 1). Although dry seeds are important and provide concentrated nourishment, a high frequency of occurrence was recorded for moist berries of shrubs, and the fruit of mistletoe (*Phoradendron* sp.) and cacti. Several spring crops contained little but the blossoms of palo-verde trees, mesquite trees, or yucca (*Yucca* sp.). In early summer at low elevations saguaro fruit was frequently the sole constituent of crops, and fall crops frequently held only the fruit of prickly pear (*Opuntia* sp.).

Quail collected from areas more than one mile from open water usually had crops containing moist leaves, buds, fruits, flower parts, and insects. Quail collected one-quarter mile or less from open water almost invariably had crops containing less green succulent material and a higher proportion of dry seeds. The moisture content of the

TABLE 1. SEASONAL CONSUMPTION OF SUCCULENT AND NON-SUCCULENT GAMBEL'S QUAIL FOODS[1]

Food Item	Volume of diet			
Non-succulent food	Spring	Summer	Fall	Winter
	per cent	per cent	per cent	per cent
Forb seeds	40.7	41.6	54.6	37.1
Shrub, tree, cacti seed	8.6	13.7	12.3	22.2
Grass seeds	0.4	2.0	1.9	7.5
Dry animal items	0.5	0.2	0.2	0.4
Sub-total	50.2	57.5	69.0	67.2
Succulent foods				
Forb leaves and flowers	15.3	4.6	15.2	7.6
Shrub-cacti leaves, fruit	28.5	16.3	5.9	19.9
Grass leaves	0	0	0	0.1
Insects	0.4	15.3	1.5	0.7
Sub-total	49.7	41.6	29.0	32.4
Totals	99.9	99.1	98.0	99.6

[1]Expressed as percent by volume.

TABLE 2. MOISTURE IN CROP CONTENTS OF GAMBEL'S QUAIL

Over 50% green material				Under 50% green material			
Month	Number in sample	Moisture content	Fraction of body weight	Month	Number in sample	Moisture content	Fraction of body weight
		percent	percent			percent	percent
June	19	70.4	3.9	June	6	48.6	2.9
July	2	75.2	5.7	July	2	38.9	1.3
November ..	7	61.8	3.8	November ..	7	45.9	3.8
December ..	3	64.7	1.7	December ..	10	45.8	3.1
April	2	63.6	2.8	April	1	40.0	1.8
May	6	65.4	2.1	May	1	46.8	2.7
Average		66.8	3.3	Average		44.3	2.6

crop material varied from less than 15 percent to more than 88 percent depending upon the season but especially with the distance from water. Crops containing over 50 percent green material averaged 67 percent moisture (Table 2).

Secretions from the mouth, throat, and crop lining appear to add only a minor amount of moisture to the crop content. The moisture percentage of a sample of twenty crops was determined; each contained a specific succulent food [filaree leaves (*Erodium* sp.), paloverde or mesquite blossoms] with only traces of other food items. Moisture content of this ingested food was compared with the average moisture content of the same plant part collected in the field. The greatest increase was less than ten percent in the sample of twenty crops. The average increase in moisture (7 percent) was not considered to be significant. There was little seasonal variation in the amount of moisture found in the crops (Table 2).

The moisture content in multiple-samples of thirty-three kinds of food consumed by Gambel's quail was determined at all seasons of the year. These data are presented in Table 3. Buds and flowers averaged 64 percent moisture; several fruits had higher moisture percentages and all succulent plant materials tested had an average water content of 66 percent.

DISCUSSION

Gambel's quail are known to use artificial water developments as do all western quails. These birds show apparent increases in numbers near these catchments, but the practicality as well as the need for catchments designed primarily for Gambel's quail is questioned.

The observations in this investigation on the behavior of Gambel's quail indicate that this species is well adapted to a desert existence. Undoubtedly this behavior is regulated by physiological mechanisms similar to those of various desert mammals (Vorhies, 1945). They consume relatively large amounts of a variety of desert plants. Some of the more deeply-rooted of these plants bear edible leaves, buds,

TABLE 3. MOISTURE CONTENT OF SOME GAMBEL'S QUAIL FOODS[1]

Type of food	Plant species	Moisture content
		per cent
Succulent fruit	Carnegiea gigantea	82.6
	Ferocactus Wislizeni	67.3
	Condalia lycioides	84.8
	Opuntia Engelmannii	82.5
	Opuntia versicolor	87.7
	Celtis pallida, C. reticulata	58.9
	Average of succulent fruit	73.9
Leaves, buds, flowers of shrubs and cacti		
	Acacia Greggii	65.1
	Aplopappus tenuisectus	68.9
	Beloperone sp.	56.5
	Calliandra eriophylla	54.7
	Celtis pallida, C. reticulata	62.5
	Chilopsis linearis	63.4
	Condalia lycioides	48.7
	Ephedra trifurca	51.0
	Eriogonum Wrightii	31.6
	Mimosa biuncifera	41.5
	Phoradendron californicum (Prosopis),	57.6
	(Olneya tesota) and	59.3
	(Acacia Greggii)	61.1
	Prosopis juliflora var. velutina (leaf)	56.6
	(buds and flowers)	63.6
	Average of leaves, buds, etc	56.1
Leaves of forbs	Ambrosia spp.	76.8
	Baileya multiradiata	52.1
	Boerhaavia spp.	56.4
	Cuscuta spp.	60.5
	Erodium cicutarium	73.4
	Helianthus spp.	74.1
	Proboscidea spp.	82.2
	Rumex spp	83.0
	Sisymbrium Irio	86.0
	Tidestromia spp.	51.8
	Average of forb leaves	68.2
Dry seeds	Average (Amaranthus, Bouteloua, Erodium)	4.8

[1]Collected during the growing season and if possible during periods of quail use. Each figure is an average of several samples.

flowers, or fruit even during critical dry periods. Cacti and other water-storing plants also frequently provide succulent fruits and flowers. This quail conserves body moisture both by seeking the coolest available areas and by remaining inactive during the hottest part of the day. Dawson (1954) found that this and certain other western quails were not harmed by an increase in body temperature of several degrees above normal body temperature. From the standpoint of water economy an increase in body temperature under high air temperatures is known to be less expensive than sweating. (Dawson, 1954). The urine of many birds is not watery under conditions of restricted water intake. Sturkie (op.cit.) concludes that there is considerable reabsorption in the cloaca and thus increased water retention. This mechanism is similar to that of the kangaroo rat (*Dipodomys* sp.) which has the ability to resorb water in the kidneys and from the bladder (Vorhies, op.cit.). These and other modifications may be quite highly developed in the desert-dwelling Gambel's quail.

An increase in catchment use by quail in consecutive years after their construction may indicate concentration of the surrounding quail population as well as (or instead of) the development of a larger local population. Little research has been done on the degree of predation near such concentrations of quail and no research reports could be found on the rate of spread of diseases and parasites at "gallinaceous guzzlers". One of the best preventatives of disease of any game bird, however, is the prevention of concentrations.

Plant growth frequently appears along the shoulders of paved highways in desert areas. Quail habitat might be improved by devices that would concentrate scanty desert rainfall and promote a growth of native plant foods. Moisture provided to the quail in succulent plant form would avoid disease and predation problems. This additional green plant food would provide added sources of carotene and should stimulate production of young (Hungerford, op. cit.).

Campbell, (op.cit.) presented good economic arguments against widespread rainwater catchment construction in New Mexico. Even the western species of quail have a low radius of movement and vast areas of land are included in the statewide distribution of quail in most of the western states. The cost of construction and maintenance of an effective network of catchments over the entire range is prohibitive. Early game bird management included numerous small refuges. These were abandoned in most states for this same reason, namely, the low radii of mobility of most upland game birds.

Although this paper is primarily concerned with Gambel's quail, more mobile game species might be greatly benefited by rainwater catchments. Arizona has generally abandoned the single-use catchment for Gambel's quail in favor of multi-purpose units providing water for big game and small game. Wright (op.cit.) in the most recent evaluation of Arizona water developments found this type to be particularly valuable for big game species. He found improvements in big game distribution and a year-long use of ranges by deer, antelope and desert bighorn that had formerly been used only seasonally. Such big game species have the mobility to make better use of wide-spread water catchments.

Continued research is necessary to determine the water relationships of many desert game species. Proper management of Gambel's quail or any other desert species should be based on a knowledge of the nature and extent of their adaptation to arid conditions.

SUMMARY

1. Native southern Arizona Gambel's quail show a dependence on moist succulent plant foods.

2. Quail without access to any moisture source other than from such foods have good survival and reproduction.

3. The calculated moisture requirement of the Gambel's quail appears to be fulfilled by the measured moisture content of natural food items. These quail also have behavioral adaptations to conserve body moisture. Known and possible physiological adaptations to conserve moisture were discussed.

4. Gambel's quail can and do subsist well without free water in southern Arizona and rainwater catchments designed for this species alone are considered non-essential.

LITERATURE CITED

Bartholomew, George A. and William R. Dawson
1954. Body temperature and water requirements in the mourning dove, *Zanaidura macroura marginella*. Ecol. 35(2):181-187.

Campbell, Howard
1960. An evaluation of gallinaceous guzzlers for quail in New Mexico. Jour. Wildlife Mgt. 24(1):21-26.

Dawson, William R.
1954. Temperature regulation and water requirements of the brown and Abert Towhees, *Pipilo fuscus* and *Pipilo aberti*. Univ. of Calif. Publ. in Zoology 59(4): 81-124.

Gorsuch, David M.
1934. Life history of the Gambel quail in Arizona. Univ. of Arizona Biol. Sci. Bull. No. 2, 89 pp.

Gullion, Gordon W.
1958. The proximity effect of water distribution on desert small game populations. Western Assn. State Game and Fish Commissioners, 38th Ann. Conf., Proc. pp. 187-189.

Hungerford, Charles R.
1960. Factors affecting the breeding of Gambel's quail, *Lophortyx gambelii gambelii* Gambel, in Arizona. Unpubl. doctorate thesis, Univ. of Arizona, 94 pp.

Leopold, Aldo
1933. Game Management. Scribner's Sons, New York.

Lowe, Charles H., Jr.
1955. Gambel quail and water supply on Tiburon Island, Sonora, Mexico. Condor, 57(4):244.

MacGregor, Wallace
1953. An evaluation of California quail management. Western Assn. State Game and Fish Commissioners, 33d Ann. Conf., Proc. pp. 157-160.

Russell, Paul
1932. The scaled quail in New Mexico. Unpub. Master's thesis, Univ. of New Mexico. 143 pp.

Sturkie, Paul D.
1954. Avian physiology. Comstock Publ. Assn., Ithaca, N. Y. 423 pp.

Sumner, E. Lowell
1935. A life history study of the California quail, with recommendations for conservation and management. Calif. Fish and Game 21(3 & 4):185-342.

Vorhies, Charles T.
1928. Do Southwestern quail require water? Amer. Nat. 62:446-452.
1945. Water requirements of desert animals in the Southwest. Univ. of Arizona Tech. Bull. 107, 487-525.

Wallmo, O. C.
1956. Ecology of scaled quail in West Texas. Texas Game and Fish Comm. 134 pp.

Webb, Edward L.
1958. Water development evaluation. Western Assn. State Game and Fish Commissioners, 38th Ann. Conf., Proc. pp. 251-255.

Wright, J. T.
1953. Quail rainwater catchments and their evaluation. Western Assn. State Game and Fish Commissioners, 33d Ann. Conf., Proc. pp. 220-223.
1959. Desert wildlife, a research study. Arizona Game and Fish Department. Wildlife Bull. No. 6, 78 pp.

DISCUSSION

DISCUSSION LEADER DUSTMAN: I wish to thank Dr. Hungerford for a very interesting paper. It should be stimulating to the audience.

MR. DOUGLAS JAMES [Fayetteville, Ark.]: There is a source of moisture to an organism that doesn't depend on the moisture in the food they eat. That's metabolic water produced through the respiration of the organic compound in the process of yielding energy. There have been some experiments in the laboratory with desert rodents which shows that they can exist solely on metabolic water in the presence of desiccated food. In other words, their only source of moisture would be the metabolic water because the food is totally dry.

I wonder if there have been any laboratory experiments with Gambel's quail, whether they, too, can survive in the total absence of water in the food?

DR. HUNGERFORD: I realized this possibility in going through the literature. I found nothing concerning that except that Sturkie in his avian physiology text and one or two others have speculated this might be possible. However, as far as I know there hasn't been any really intensive research on that problem. Sturkie said he felt they can conserve metabolic water. Whether they actually generate it as speculated by other authors is unknown.

DR. ARNOLD O. HAUGEN [Ames, Iowa]: I wonder about the information on the reproductive success on quail that were living in areas where they had no open water as against in areas where they had open water.

DR. HUNGERFORD: On the three study areas we observed the individual coveys, identified by the size of broods and the number of individuals in coveys. We had a rather small sample, but there was no apparent difference in young production between those in water sources and those living completely on succulents.

MR. BEN GLADING [Sacramento, Calif.]: I guess I really ought to get in this. It's real interesting to notice that in many cases the application of guzzlers has preceded the basic research that should have been done locally before the guzzler was put out.

Dr. Hungerford mentioned one reference to the physiology of the California quail that was the Summer study which was done in a moister section of the state. We find in California that guzzlers are effective over a third of the valley quail range in effective quail management. The balance of the valley quail range in California is characterized by either summer fog which sets quite a bit of dew on the ground and apparently meets the quail's moisture requirement or is characterized by abundance of late summer annuals, composites. The quail eat the flower heads of those and they apparently supply the summer moisture.

In the balance of the valley quail range where we in California have put the bulk of our guzzlers, both of these natural summer water factors are, by and large, lacking. In our regional study area in which the guzzler was developed we did notice quite dramatically this difference between birds that were a mile to a mile and a half back from normal watering sources, and we noticed there were quail that existed in small coveys back from normal water areas. Under natural situations, you find sizeable coveys located around water. Of course, this is the thing that gives us the idea of water as a possible management tool.

In these coveys that were a mile or a mile and a half back from summer water there was almost a total lack of reproduction. Apparently the adults could get by with little or no moisture, but they were fairly unsuccessful as far as production was concerned. On the other hand, at natural summer water, not guzzlers, but later corroborated with guzzlers, had very adequate production of young. This difference was only in what we would call the drier section of California, its inner coast range, and the coast range in Southern California.

We have a few scattered in the Sierra, but for some reason largely because of late summer composites, we feel are not successful in producing the tremendous coveys we get in a fairly circumscribed area from about the middle of inner Monterey County on south.

We have Gambel quail too. We again find they are not as effective in producing what we would call good management results as they are in this favorable portion of the valley quail range.

As I see this in summary, we in California developed the guzzler as a result of experiments in an area where they later proved to be real effective. It's a little disheartening perhaps that on anybody's original enthusiasm to find a new tool, we grabbed it willy-nilly and tried to make it apply to our local situation instead of doing basic research ahead of time. Thanks.

DR. STARKER LEOPOLD [Berkeley, Calif.]: I would like to speak briefly about my observation on the western quails in New Mexico. I thoroughly agree with Dr. Hungerford that populations of western quail seem to fluctuate largely with the supply of succulent food, not with the supply of drinking water. That is to say, in the wet year in the New Mexico uplands there will be enormous numbers of young quail produced, and in a dry year apparently because of lack of succulent foods the birds don't even pair. There is no attempt at reproduction. Nevertheless, interpreting this and applying it on a management basis, it must be kept in mind that in areas that are subject periodically to absolute drought, meaning complete absence of succulent foods, there may be no breeding stocks at all unless there is drinking water which permits the birds to utilize the food resource of dry seeds.

Dr. Hungerford said that in the absence of drinking water they can't live on dry seeds. They must at least combine a large element of succulents in the diet.

Arizona, the area where Dr. Hungerford was making his study, typically has two periods of precipitation a year, a summer rain period and a winter rain period and absolute drought in Arizona is not usual. In Baja California, on the other hand with the total average rainfall of four inches on the peninsula, and times for two or three years consecutively no rainfall at all, the only breeding stock that exists is near water. Therefore, this has to be applied as a sliding scale.

There are places where drinking water is absolutely essential to maintain the breeding stock, but the performance of that breeding stock in producing a big crop is indeed a matter of succulent foods, and that means rainfall.

DR. HUNGERFORD: Dr. Leopold, this was part of the over-all study concerning the factors in reproduction of Gambel's quail and this water requirement was one phase of that study.

You might be interested to know that we correlated the vitamin A storage in livers of these birds in wet and dry years, and compared that with the amount of low annual plant growth, and the young in that population, their vitamin A storage, and we found a very definite correlation. Under low vitamin A storage the birds had a low reproduction count and did not pair off. Under years with good late-winter and spring rainfall and high vitamin A storage, there was high reproduction, with vitamin A as the controlling factor or perhaps some other associate substance with it.

I was wondering if you had observed that same thing in those arid conditions of New Mexico. Did the birds start to breed with minor amounts of rain you do get in that area?

DR. LEOPOLD: Breeding production is a function of rainfall and succulent foods, definitely, yes.

MR. GLADING: Just one more observation. In this element there is a vast difference between California quail and desert and scaled quail. In California quail the areas where the guzzlers are effective there is no lack of green food at the time the quail start their nesting cycle. Very dramatically just about the time the quail starts the nesting cycle, they have food available to start it. It then dries up and it's during the summer period where you have a critical situation as to whether young survive or not. Here I think is the real vast difference between what happens in valley quail which are really not truly a desert species versus what happens in true desert.

BOBWHITE QUAIL: A PRODUCT OF LONGLEAF PINE FORESTS

VINCENT H. REID AND PHIL D. GOODRUM

Bureau of Sport Fisheries and Wildlife, Fort Collins, Colorado and Nacogdoches, Texas

The bobwhite quail (*Colinus virginianus* Linnaeus) is a natural resource of southern pine forests. Longleaf pine (*Pinus palustris* Mill.) land, in particular, with its natural openings, network of numerous small stream bottoms, baygalls and ravines, scrub oak ridges or flats, and luxuriant ground mantle provides good quail habitat. As part of an ecological study of quail on longleaf pine range, bobwhite population trends, young: old ratios and climatological information were gathered and are presented in this paper.

LOCATION AND HISTORY

The study was conducted primarily on Kisatchie National Forest lands in Vernon, south Natchitoches and western Rapides Parishes in Louisiana. These three Parishes, containing approximately two million acres of commercial forest land, are located in the southwestern portion of the longleaf pine belt (U. S. Forest Service, 1955).

Farming operations have been minimal in the uplands of this tri-Parish area, which is part of what the forest surveys term Unit Three or southwestern Louisiana (Cruikshank, 1939; U. S. Forest Service, 1955). One of the finest stands of longleaf pine in the South originally covered the uplands of this unit (Cruikshank, 1939). However, the land at present supports all stages of forest growth: extensive clearcut; natural and artificial pine regeneration; young and second growth sub-log size stands; merchantable second growth; and some remnants of the original old-growth trees.

METHODS

Winter quail inventories were made with bird dogs under these varied forest conditions from 1949 through 1955 and results expressed as covey finds per hour. Acres-per-covey and acres-per-bird figures were approximated from the time data by assuming that the dogs covered about 50 acres for each hour afield.

To follow population trends at the time of the breeding season, quail whistle counts were made by driving 20-mile routes on secondary roads with three-minute listening stops at one-mile intervals. The routes were started one-half hour before sunrise and the number of whistling cocks heard on each stop was recorded. The routes were run annually, 1953 through 1956, between May 20 and June 10. Five routes were inventoried in the three-Parish area.

To determine annual production, quail wings were obtained from hunter cooperators in 1947 and 1949 through 1957. Young: old ratios and hatching date determinations were made by techniques described by Stoddard (1931), Leopold (1939), and Petrides and Nestler (1943 and 1952).

For comparisons with annual population and production figures, temperature and precipitation records for Leesville, Louisiana, which is centrally located in the study area, were used (U. S. Weather Bureau, 1947, 1949-1957).

RESULTS

Winter inventories. The limitations of bird dogs for inventorying quail on forest land where continuous vegetative cover occurs, have been pointed out by Stoddard (1931) and Lay (1940). Some coveys are missed; hence, the figures obtained in this inventory are minimal and more properly reflect "hunter-find" success rather than total covey or bird numbers.

Field work with dogs showed that quail populations were best in the winters of 1949 and 1955 (Table 1). In these years, the dogs averaged a covey find per 1.7 and 1.9 hours, respectively. The "hunter-find" success approximated a covey per 87 acres in 1949 and 98 in 1955. The acres per bird figure was about seven in 1949 and eight in 1955.

Population lows were recorded in 1951 and 1954 when the dogs averaged a covey find for about 3.5 and 2.9 hours afield, respectively. The "hunter-find" was about a covey to 176 acres or a bird to 16 acres in 1951 and a covey to 146 acres or a bird to 13 acres in 1954.

Quail populations in other years varied between these extremes and averaged about a bird to nine acres.

TABLE 1. WINTER QUAIL POPULATION TRENDS AND YOUNG:OLD RATIOS, SOUTHWEST LOUISIANA, 1949-1955

Year	Hours per covey find	Acres per covey (est.)[1]	Acres per bird (est.)[2]	Young:old ratio
	No.	*No.*	*No.*	*Percent*
1949	1.7	87	7.3	82:18
1950	2.1	106	8.9	74:26
1951	3.5	176	16.2	66:34
1952	2.1	108	8.9	74:26
1953	2.2	115	8.8	76:24
1954	2.9	146	12.6	67:33
1955	1.9	98	8.1	80:20

[1]Estimated that the dogs covered 50 acres for each hour afield.
[2]When incomplete counts on the number of birds in a covey were made the average covey size for the season was substituted and used in calculating the total number of birds.

TABLE 2. WINTER QUAIL POPULATION TRENDS, UNHUNTED POPULATION, RED DIRT GAME MANAGEMENT AREA, KISATCHIE NATIONAL FOREST, LOUISIANA, 1949-1955

Year	Hours per covey find	Acres per covey	Acres per bird	Young:old ratio
	No.	*No.*	*No.*	*Percent*
1949	1.4	73.0	5.6	....[1]
1950	0.9	123.6	9.3	....
1951	1.5	97.1	9.5	....
1952	1.4	97.1	9.5	....
1953	0.8	97.1	7.6	....
1954	2.5	170.0	14.0	....
1955	1.6	75.0	6.7	78:22

[1] .... No data.

A similar inventory was made with bird dogs on a 1360-acre block on the Red Dirt Game Management Area, Kisatchie National Forest, Louisiana (Table 2). Here an effort was made to find all coveys on the tract. This population was unhunted between 1941 and 1955, so that it had eight years' protection before the first inventory in 1949 and 14 years by the time of the last one in 1955.

Generally, it was found that the trend in quail populations on the protected and unprotected areas was about the same.

Quail whistle counts. Whistle counts were used to measure quail population trends each year at the time of the breeding season. Referring to quail whistle counts as an inventory method, Stoddard (1931) concluded that: "The method is of no value except in the early part of the nesting season when 'bobwhite' whistling is general. At this time it will give an approximation of the breeding population."

For the hundred stations on the five quail whistle count routes, the number of calls heard per stop varied from 2.32 to 1.89. An analysis of variance showed no significant difference in the number of calls heard per stop in the four years that the routes were run. Therefore, if quail whistle counts are reliable indicators of quail populations early in the breeding season then, despite annual fluctuations in winter, the population at the beginning of summer was about the same each year.

Young:old ratios. The young:old determinations showed annual fluctuations in the percentage of birds less than a year old occurring in the winter population (Table 3). An analysis of variance showed a significant difference in the percentage of young birds among years. Most young were found in 1949 and 1955 with the percentages of 82 and 80, respectively. There were four or more young birds per adult in these years. Fewest birds-of-the-year were found in 1947, 1951, 1954, and 1956, with percentages of 60, 66, 67, and 60, respectively. The young:old ratio was two or less young per adult. The percentage of young in other winters varied only from 74 to 77 percent; the young:old ratio was about three young per adult bird.

TABLE 3. PERCENTAGE OF YOUNG, PRECIPITATION AND TEMPERATURE DATA FOR THE QUAIL REPRODUCTIVE SEASONS, SOUTHWEST LOUISIANA, 1947, 1949-1957

Year	Wings examined	Young[1]	Young per adult	Highest average maximum monthly temperature[2]	Precipitation April through October
	No.	*Percent*	*No.*	*Degrees*	*Inches*
1947	275	60.4	1.5	98.9	18.77
1949	963	82.5	4.7	91.0	30.34
1950	703	73.7	2.8	92.7	34.71
1951	903	65.8	1.9	97.1	26.68
1952	950	74.3	2.9	93.2	33.09
1953	1125	76.4	3.2	94.7	56.04
1954	501	66.9	2.0	97.6	20.72
1955	1509	80.3	4.1	90.2	38.62
1956	260	60.0	1.5	94.6	16.77
1957	573	77.5	3.4	93.9	37.88

[1]Percentage of young figures for 1956 and 1957 furnished by the Louisiana Wildlife and Fisheries Commission.

[2]All highest average maximum monthly temperatures occurred in August except for June in 1953.

The 40,000-acre Red Dirt Game Management Area, previously mentioned as having protection for 14 years, was opened for bobwhite hunting in December, 1955. Wing collections indicated a young:old ratio of 78:22 (Murry, 1956, 1959). This ratio was remarkably close to the 80:20 figure obtained from the surrounding area which had been hunted annually (Tables 1, 2). It shows the high annual turnover in bobwhite population that can be expected here even with several years protection from hunting.

Young:old ratios and population trends. Bird-of-the-year percentages were compared with winter quail populations expressed in hours-per-covey find. Annual production was highest in the better quail years, 1949 and 1955, and lowest in the poor quail years, 1951 and 1954. A regression analysis showed a significant relationship between hours-per-covey-find and the percentage of young (Fig. 1). The better winter quail populations (lowest hours-per-covey-find) were directly associated with years having high annual production. For these years and in this locality, the data stressed the importance of current production to a good population the following hunting season.

Variation in percentage of young during the hunting season. For eight of the years a monthly comparison of the percentage of young, as the season progressed from November or December to mid-February, was made. The differences in monthly percentages were never great, and no general downward trend in percentage of birds-of-the-year was apparent. An analysis of variance indicated no significant difference in the percentages among months for any one season.

The percentage of young quail in the December wing sample, or the

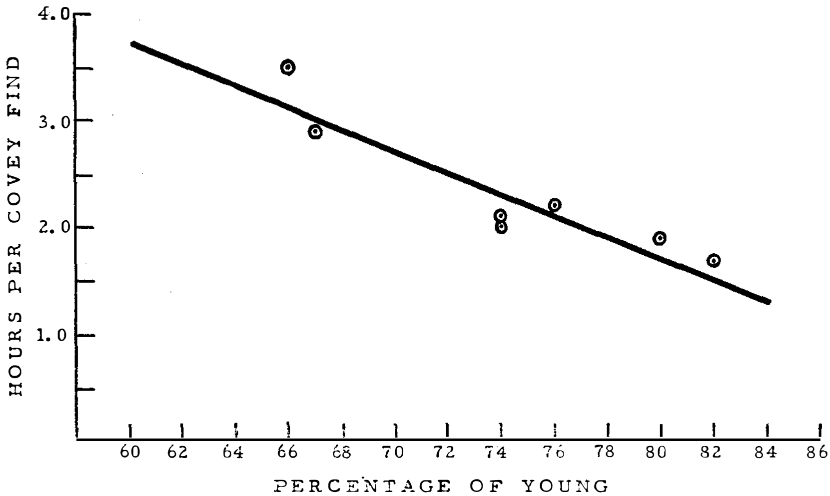

Figure 1. The relationship between the percentage of young and the quail inventory figures, 1949 through 1955.

November and December sample in the years that the hunting season had a late November opening, closely approximated the bird-of-the-year percentage arrived from the entire hunting season sample. The difference in percentage was never greater than ± 2.4, and suggests that, for this locality, an adequate early sample will give a fairly reliable indication of the current season's crop of young.

Percentage of young and hatching dates. From 1952 to 1955 the hatching dates of young birds were determined by measurement of the primary feathers (Petrides and Nestler, 1943). It was not possible to date the hatch of all young birds because of the late opening and length of hunting season. Some of the early hatched young were older than 150 days at the beginning of the hunting season, and the primary wing moult was advanced beyond the point where feather measurements could be used to age the birds by weeks or days and back date to the hatching period. As the season progressed an increasing proportion of the birds grew into this category. Therefore, the percentages for late hatched birds shown here are minimal.

Of those birds for which hatching dates were determinable, 41.5 percent in 1955, 4.5 in 1954, 15.7 in 1953, and 12.0 in 1952 pipped after July 31. Thus the wing sample depicted a large late hatch in 1955, a good quail year, and a very small late hatch in 1954, a poor quail year. These data suggest that a good late hatch was important in bringing about the high annual production figure and good winter population in 1955, and they stress the importance of a long and successful reproductive season to high winter populations in this part of the range.

Abundant production or strong late hatches of quail were reported from other areas in 1955. Haugen and Speake (1958) in a six-year study of quail wings in Alabama, found that quail production was most abundant in 1955 (83.5 percent), and that over 50 percent of the birds were hatched after July 1. Their study also showed 1954, a drought year in Alabama, as the poorest year for production. Cottam and Glazener (1959) reported an almost complete failure of bobwhite reproduction at the Welder Refuge, Texas, in the dry spring and early summer in 1955. But, with soaking rains in September, a sizeable late crop of birds was produced.

Production in other areas. The percentages of young in our Louisiana study varied from 60 to 82 with 10 years of data. Percentages from other areas have shown somewhat less variation: Texas, 70 to 86 (Lay, 1952); Alabama, 70 to 83.5 (Haugen and Speake, 1958); Tennessee, 72 to 84 (Legler, 1955); Missouri, 72.6 to 82.4 (Leopold, 1945), and Missouri, 79.2 to 84.4 (Bennitt, 1951). It appears that greater fluctuation occurs in the bird-of-the-year percentages in the southern periphery of the bobwhite range than in the more centrally located areas. This point was also noted by Lay (1952) in review of Bennitt's (1951) study of bobwhite population structure in Missouri which showed a change from only 79.2 to 84.4 percent over a 10-year period.

Various causes, including extremes in weather, have been investigated or suggested as being responsible for fluctuations such as these in annual bobwhite production.

Temperature and population trend. Population changes and those in annual production in our Louisiana study were compared with temperature and precipitation records for the area. The population trend, expressed in hours-per-covey-find was found to be a linear function of the highest average maximum monthly temperatures (Fig. 2). The better winter populations (lowest hours-per-covey-find) followed the cooler summers.

Temperature and annual production. As mentioned earlier, there was a significant correlation between winter quail populations and production of young for this tri-Parish area. Therefore, relationships of annual production to precipitation and temperature also reflect population comparisons.

Annual bobwhite production figures were compared with the maximum daily temperatures for the preceding warm-month period and also with the highest average maximum monthly temperature for the summers.

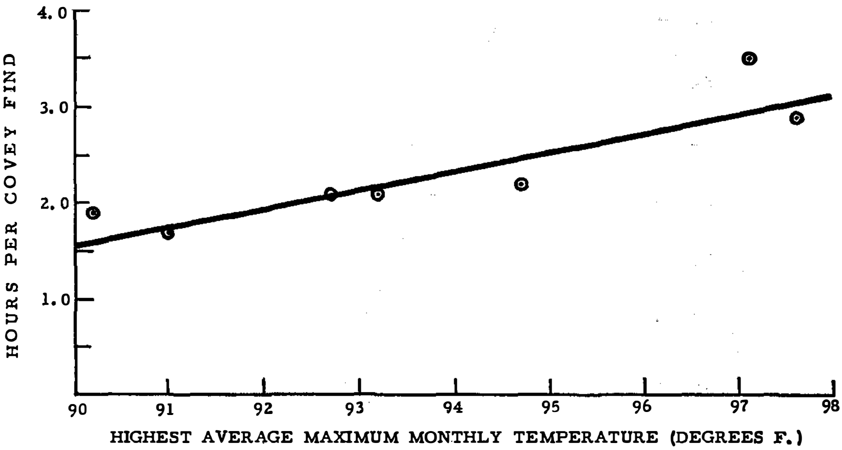

Figure 2. The relationship between the highest average maximum temperature and the winter population, 1949-55.

Best annual production (74 percent or more) was found in the six years when the maximum daily temperatures during summer never exceeded 99°F. On the other hand, when maximum daily temperatures of 100°F. or more were recorded as they were in the summers of 1947, 1951, 1954, and 1956, annual production was 67 percent or less. Temperatures over 100°F. were registered in July, August and September, 1947, while in the other years the high readings usually occurred in July and August.

The maximum summer readings are reflected, of course, in the average maximum monthly temperatures. A comparison was made of the highest average maximum monthly temperature recorded during the summer for the years 1947 and 1949 through 1957 with annual production (Table 3). All high average maximum monthly readings occurred in August except for 1953 when June was the high month. Annual production was best (1949 and 1955) when the highest average maximum monthly temperature was no greater than 91°F. In the poor production years of 1947, 1951, 1954, and 1956 (67 percent or less) the highest average maximum monthly temperatures, with one exception (1956 with 94.6°F.) exceeded 97°F.

In a regression analysis, annual production was related to the highest average maximum monthly temperatures; the regression was linear and significant at the one percent level (Fig. 3). In general, best annual production was recorded following the cooler summers while poorer reproductive success was registered following hot summers.

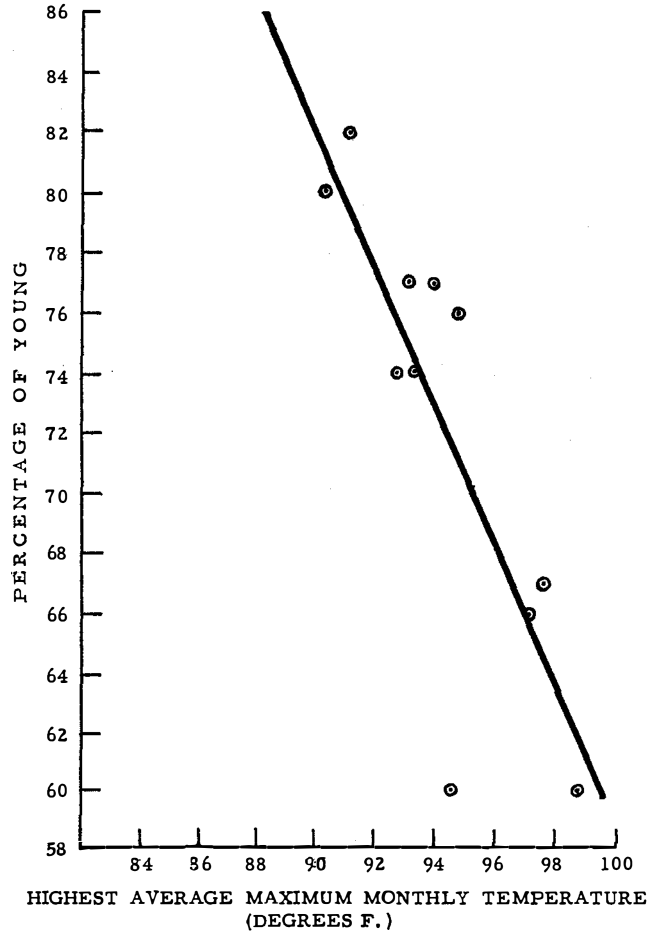

Figure 3. The relationship between the highest average maximum temperature and the percentage of young, 1947 through 1957.

Precipitation and annual production. Field observations and wing examinations indicated that the reproductive season extended from April into October, so precipitation figures for these months were used in comparison with annual production.

Most young appeared in years when more than 30 inches of rain fell during this period; poor production was recorded for seasons with less than 27 inches (Fig. 4). The span of precipitation for the better production years was from 30 to 56 inches. The percentage of young was 74 or more for these years; and it was 67 or lower when rainfall was less than 27 inches. Generally, a positive relationship between quail production and precipitation existed. With a decrease in the amount of precipitation, there was a drop in bobwhite production, and with an increase in rainfall, there was an upsurge in quail production.

DISCUSSION

Lack of temperature and humidity regulation during the egg-laying period and after incubation has begun may influence annual production in this part of the range. During this study air temperatures above 120°F. were recorded at the surface of the ground. Such heat is well over the 102°F. required for incubation of quail eggs, and may be sufficiently high to trigger growth before incubation has begun, cause egg spoilage during the laying period, or at times when the nest is unattended after incubation has begun. It seems likely that the nesting bird's chances of capturing the desired temperature and humidity (55 to 60 percent) for successful incubation would be enhanced in summers when ground surface temperatures do not soar so high and there is an adequate and even distribution of rainfall to help maintain the proper humidity.

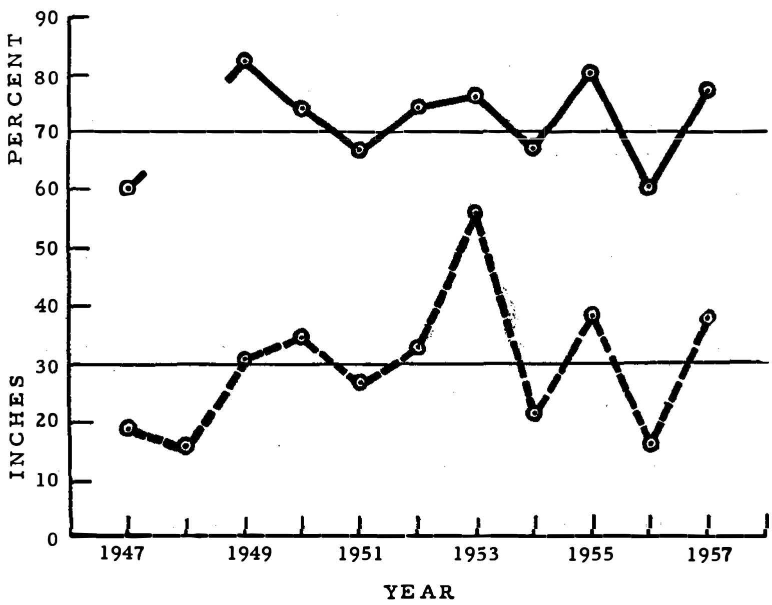

Figure 4. Comparison of the rainfall for the warm-month period, April through October, and the percentage of young, 1947 through 1957.

Loss of the urge to nest or renest in hot dry periods (Stoddard, 1931 and Lehmann, 1953), whether from lack of essential nutritional requirements for sustained reproductive activity (Nestler, 1946), some other physiological reason, or unfavorable environmental conditions (Cottam and Glazener, 1959), would curtail annual production and influence winter populations. Likewise, the survival of young during the critical growth period may be poor because of the inferior quantity and quality of foods produced in hot dry summers (Haugen, 1955; Nestler, 1946; Nestler, DeWitt, Derby, 1949).

SUMMARY AND CONCLUSIONS

In this forest quail study in southwestern Louisiana, marked fluctuations in annual production and populations were recorded. The better winter bobwhite populations were significantly related to high reproductive success the preceding nesting season. The population trend was much the same on hunted and unhunted longleaf pine range, and the percentage of young birds found on an area protected from hunting for 14 years closely approximated that for the surrounding annually hunted area. One of the best reproductive seasons had a good late quail hatch. Significant relationships were found between annual production and temperature and between annual production and precipitation records for the preceding summer months. In general, the best quail crops followed cool moist summers while poorest reproductive success followed hot dry summers. Temperature and precipitation readings during the warm-month period may be useful criteria for predicting annual quail production and winter populations in this area.

ACKNOWLEDGMENTS

We are deeply appreciative for the fine assistance received from various members of the Louisiana Wildlife and Fisheries Commission in gatherng inventory data and quail wings, and for furnishing young:old records for 1956 and 1957. In particular, special thanks are due H. C. Beasley, C. E. Harrison, J. D. Newsom, R. E. Murry, and C. J. Perkins. Excellent cooperation was received from many hunters in supplying wings. Sincere appreciation is expressed to Joseph and William Broyles, Lewis Brown, F. E. Hernandez, Thomas and Travis Howard, James Leatherman, Edgar and Leon McKee, C. W. Shankle, Paul and Peter Sliman and especially W. R. Wills for exceptionally fine support throughout the study. We also wish to thank J. L. Kovner and Geraldine Peterson, Rocky Mountain Forest and Range Experiment Station, for statistical help.

LITERATURE CITED

Bennitt, Rudolf
1951. Some aspects of Missouri quail and quail hunting. Missouri Conservation Commission. Technical Bulletin No. 2, 51 pp.
Cottam, Clarence, and W. C. Glazener
1959. Late nesting of water birds in south Texas. Trans. 24th N. A. Wildlife Conf., pp. 382-395.
Cruikshank, James W.
1939. Forest resources of southwest Louisiana. Forest Survey Release No. 43. Southern Forest Expt. Sta. U. S. Forest Service. 38 pp.
Haugen, Arnold O.
1955. Alabama quail and quail hunters. Alabama Conservation 27(2):4-5.
Haugen, Arnold O., and Daniel W. Speake
1958. Progress report on Alabama bobwhite quail wing study. Proceedings of the Twelfth Annual Conf. Southeastern Association of Game Commissioners. pp. 260-269.
Lay, Daniel W.
1940. Bobwhite populations as affected by woodland management in eastern Texas. Texas Agr. Expt. Sta., Bul. No. 592. 37 pp.
1952. (Review) Some aspects of Missouri quail and quail hunting by Rudolf Bennitt. Tech. Bul. No. 2. Missouri Conservation Commission. *In* Jour. Wildlife Mgmt. 16:102-103.
Legler, Eugene
1955. Quail wing roundup gives valuable data. Tennessee Conserv. 21(8):17.
Lehmann, Valgene W.
1953. Bobwhite population fluctuations and vitamin A. Trans. 18th N. A. Wildl. Conf., pp. 199-246.
Leopold, A. S.
1939. Age determination in quail. Jour. Wildl. Mgmt. 3:261-265.
1945. Sex and age ratios among bobwhite quail in southern Missouri. Jour. Wildl. Mgmt. 9(1):30-34.
Murry, Robert
1956. Quail study. Sixth Biennial Report, Wildlife and Fisheries Commission, State of Louisiana, 1954-1955. pp. 107-108.
1959. Bobwhite protection. Louisiana Conservationist 11(2):9-11, 24.
Nestler, Ralph B.
1946. Vitamin A., vital factor in the survival of bobwhites. Trans. 11th N. A. Wildlife Conf. 176-195.
Nestler, Ralph B., J. B. DeWitt and J. V. Derby, Jr.
1949. Vitamin A storage in wild quail and its possible significance. Jour. Wildlife Mgmt. 13(3):265-271.
Petrides, George A. and Ralph B. Nestler
1943. Age determination in juvenile bobwhite quail. The American Midland Naturalist. 30(3):774-782.
1952. Further notes on age determination in juvenile bobwhite quails. Jour. Wildlife Mgmt. 16(1):109-110.
Stoddard, H. L.
1931. The bobwhite quail: its habits, preservation, and increase. Charles Scribner's Sons, New York, N. Y. 559 pp.
U. S. Forest Service
1955. Forest of Louisiana, 1953-1954. Southern Forest Expt. Sta., Forest Survey Release No. 75, 64 pp.
U. S. Weather Bureau
1947, 1949-1957. Climatological data, Louisiana. Vols. 52, 54-62.

DISCUSSION

MR. JOHN STEELE, JR. [Longdale, Okla.]: Back in 1956 we had 13 inches of rainfall on the Canton hunting area on which I happened to be making a study. We had 2700 birds killed and lost. In 1958 we had around 40 inches of rainfall, and our killed and lost birds soared to 4565. We don't check all the hunters by any means. What is misleading about some of our rainfall and temperature data as expressed in this paper is that there is a lag sometimes, a carryover of high population past the time that critical conditions actually set in. Is there any explanation in your paper or in your work that could explain more to me about why the 1956 population was so high, with a very critical drought in the winter and fall of the preceding year and into the summer?

MR. REID: That could be a carryover, I suspect, and also it would fall in line with the precipitation records that we are having during the summer season, too. The more moisture, even though it may seem excessive, the more reproduction we have.

MR. BEN GLADING [Sacramento, Calif.]: This is in the nature of a comment. I think that the gentleman has a very good point when he states that you can probably predict quail population on the basis of rainfall and rainfall pattern, and I think this would help answer this gentleman's question. It doesn't depend entirely on the total rainfall, and it isn't necessarily a lot of rainfall that gives you the best quail production. The optimum situation is what is going to give you the best production.

In California, valley quail, exist in rainfall belts up to 80 inches a year and down to 10 or 12 inches a year. In what we consider a generally dry year, quail are more successful in wetter portions of the state. In what we consider a wet year, quail are generally successful in the dry sections of the state. Of course, this is tempered with rainfall pattern. If we get continuing rains on through June we have a particularly successful year in spite of the over-all total. The optimum is the thing we should seek throughout the whole range, and I suspect this would apply to bobwhite quail as well as valley quail.

You have the difficulty of having a big range. We have a range almost within our state and can watch almost the whole thing.

MIGRATIONAL HOMING, LOCAL MOVEMENT, AND MORTALITY OF MOURNING DOVES IN MISSOURI

ROY E. TOMLINSON
Department of Game and Fish, Santa Fe, New Mexico

HOWARD M. WIGHT
Missouri Conservation Commission, Columbia

AND THOMAS S. BASKETT
Cooperative Wildlife Research Unit, University of Missouri, Columbia[1]

The purpose of this paper is to report on the migrational homing and local movement of mourning doves in north central Missouri. Also included in this report is a comparison of mortality rates based on recoveries and returns. This paper employs data collected from a summer banding program begun in 1953 but is based principally on data from 1957 and 1958. The work was carried out on and near the Fountain Grove Wildlife area in Linn and Livingston counties.

The objectives of the study were as follows:

1. To determine time of flock formation and departure dates of juveniles from the area.
2. To compute and compare mortality rates from recovery and return data.
3. To determine the accuracy of migrational homing.
4. To determine the extent of local movement and its effect on the measurement of accuracy of homing.

Missouri Conservation Commission personnel originally confined trapping to an area with a diameter of approximately one mile. In 1957 this was expanded to comprise an area with a diameter of about five miles. Traps were set along the edges of roadways at intervals of approximately one-fourth mile (Figure 1). Fifty-five traps were used in 1957 and fifty-four in 1958. The trap used was a modified version of the Thompson two-celled trap. Traps were checked four or five times a day.

Doves were banded with U. S. Fish and Wildlife Service number 3A bands. All adults and some young were released immediately after banding. Most young were put in cages, transported to the Fountain Grove Wildlife Area headquarters, dyed, and released when dry, at the point of capture. The young birds were dyed a separate color during June, July, and August using methods described by

[1]U. S. Bureau of Sport Fisheries and Wildlife, Wildlife Management Institute, Missouri Conservation Commission, and University of Missouri cooperating. The senior author was an Edward K. Love Fellow. Dr. William H. Elder, Rucker Professor of Zoology, University of Missouri, made useful criticisms of the manuscript. We also thank Hamlet B. Clark, Area Manager, Missouri Conservation Commission, and his entire staff for assistance and the use of facilities at the Fountain Grove Wildlife Area.

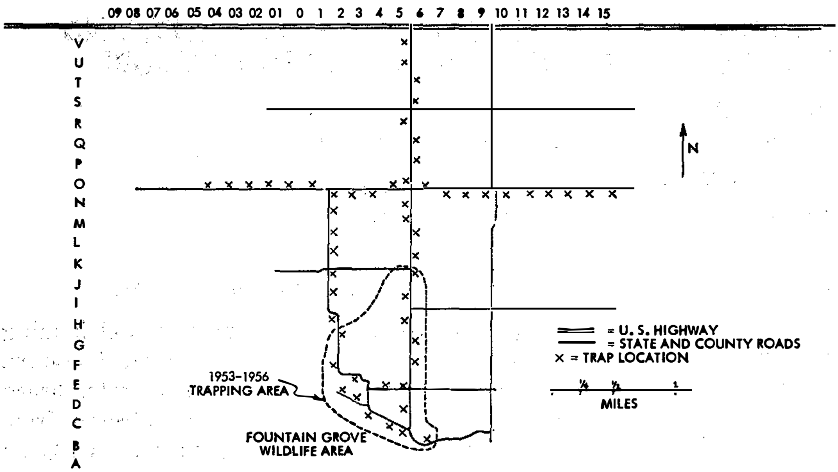

Figure 1. The trapping area.

Winston (1954) to help determine the time of their departure from the area.

SEX RATIOS

Sex was determined by color of plumage as described by Petrides (1950). In the summer of 1957, the ratio of adult males to females was 178:100, and in 1958, 161:100. The preponderance of males in both years was probably due to sex differences in incubation schedules. Because male doves incubate from about 8:00 a.m., to 4:00 p.m., they have restricted daylight time to feed, therefore males are probably less wary of traps than females. Trapping success was much greater during early morning and late evening when most males were off the nest. During this time males greatly outnumbered females in the trapped sample. In the middle of the day, fewer birds were caught and females outnumbered males. Thus, summer trapping appears to bias sex ratio data in favor of males.

AGE RATIOS AND DEPARTURE OF YOUNG FROM THE STUDY AREA

Young doves were distinguished from adults in the hand by white tipping of the greater primary wing coverts according to the method of Pearson and Moore (1940). This criterion was useful until late summer when both adults and early-hatched juveniles were completing their molts. At this time, young of the year could be confused with adults. Although doves can be aged by examination of the bursa of Fabricius (Wight, 1956), this method was not used because of possible injury to the birds. Possibly a small error was introduced by inaccurate aging during the last two weeks of banding.

Table 1 shows the percentages of adults and juveniles caught during each month of the trapping season. The proportion of juveniles increased each month until they equalled the adults.

TABLE 1. MONTHLY AGE COMPOSITION OF TRAPPED SAMPLE, 1957 AND 1958

Month	No. of Adults	No. of Juveniles	% Adults	% Juveniles
June	438	46	90	10
July	345	100	78	22
August	260	116	69	31
September	67	72	48	52

The percentage of juveniles found in September was considerably lower than that reported for shot samples. In Missouri in three years of bag checks, the percentage of young ranged from 61.0 to 77.8 percent. The Mourning Dove Investigations (1957) reported 70.2 to 71.7 percent young in three year samples of doves trapped in several southeastern states. We feel that the percentage of juveniles trapped is low in our September data because our trapping was confined to roadsides; it was designed primarily to catch nesting birds. This procedure did not adequately sample the large flocks, composed mostly of juveniles, that feed in grain fields during this period. It is these flocks that hunters seek, thus bagged samples could be expected to show higher percentages of young and so would trapping operations oriented toward volume trapping of flocks.

The points of origin are not known for the young contributing to the progressive increase in percentages shown in Table 1. Many were locally-reared birds, but others may have hatched a few miles away, and still others may represent an influx of northern-reared young.

We do know that juveniles leave the natal area soon after fledging. Ninety-five percent of all juveniles retrapped in 1957 and 1958 were taken within two weeks of the original capture date. Adults were retrapped in more constant proportion throughout the entire period of thirteen weeks (Figure 2). It seems unlikely that mortality after fledging would be of such magnitude or so sudden as to account for this disappearance of the young. The 1955 and 1956 retrap records also show that all juveniles retrapped were taken within two weeks of the time of original capture (Figure 3).

Another indication that banded juveniles were not present to be retrapped and had moved from the study area was that twenty-four percent of the total birds trapped were juveniles, but only six percent of retrapped birds were juveniles.

One might wonder whether these results are due to a peculiarity

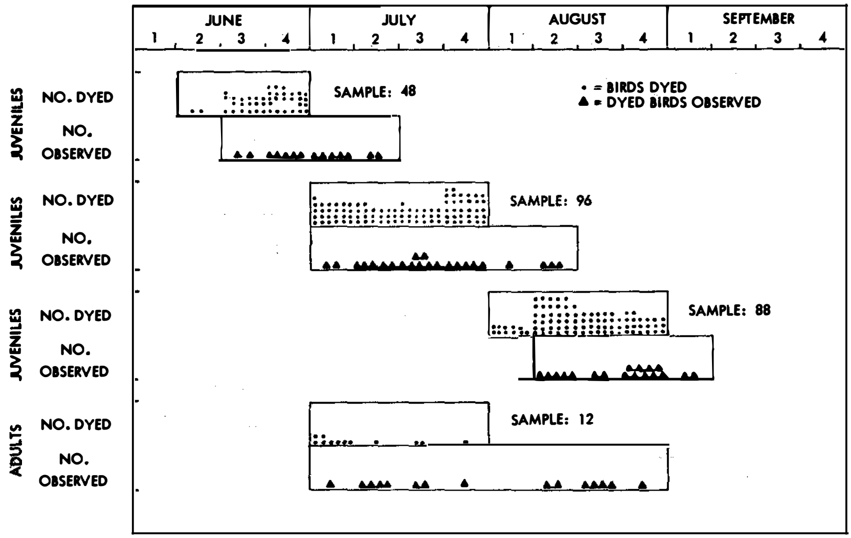

Figure 2. Time distribution of retrappings, 1957 and 1958.

of the trapping system. To check this possibility, young doves were dyed a distinctive color each month of the summer during 1957 and 1958. No juvenile was observed longer than two weeks after applying its color. However, in July, 1957, adults were dyed with a color differing from that of juveniles; these dyed adults were seen throughout August. Once again, juveniles apparently left the area quickly but adults stayed; and, in the case, no trapping bias could be inferred. (Figure 4).

MORTALITY RATES

Mortality Rates Calculated From Recoveries.

In samples of doves of mixed ages, first year mortality is higher than that of subsequent years. For example, in Mourning Dove Investigations (1957), first-year mortality was found to be between 60 and 70 percent, but the mean annual mortality rate after the first year was 50 to 55 percent. This is due to the higher mortality rate of the young birds in the sample (Austin, 1951). Because all birds are adult after the first year, the mean annual mortality rate, after the first year, represents adult mortality. The mean annual mortality rate for all years represents annual mortality for the population as a whole.

Austin (*op. cit.*) found a first-year mortality rate of 74 percent and a mean annual mortality rate after the first year of 55 percent

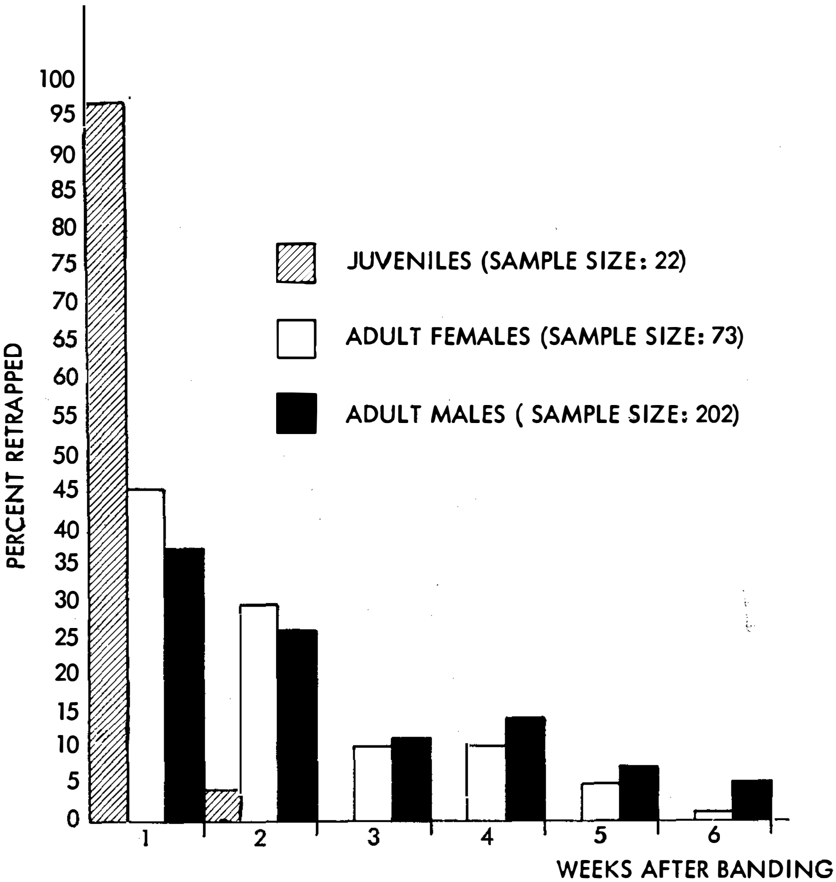

Figure 3. Time distribution of retrappings, 1955 and 1956.

on Cape Cod. Many of his birds were recovered in the Southeast. First-year mortality rates of birds banded or recovered in southeastern states are 10 percent higher than first-year mortality rates of those banded or recovered elsewhere (Mourning Dove Investigations, *op. cit.*). The mortality rates outside that area from the latter study were 60 percent for the first year and about 51 percent after the first year. Missouri data showed a mean annual mortality rate after the first year of 52 percent (Wight, 1957).

Mortality Rates Calculated From Returns.

The types and structure of life tables have been explained by Hickey (1952). A composite life table was constructed from returns in this study and treated as a dynamic life table for a hypothetical population (Table 2). Mortality rates were derived from the table.

Construction of life tables normally requires the lapse of a number of years in order to obtain records of returns and recoveries during the entire life span of each cohort. In the present study there was not sufficient time to obtain all return and recovery records. Also, trapping effort varied from year to year, changing the number of birds it was possible to sample. As Hickey *(op. cit.)* suggested for such cases, recoveries and returns were expressed as year-by-year percentage of the cohort originally banded. The percentages obtained were used in the life table instead of the actual numbers of birds. This corrected for both inadequacies.

Changing patterns of hunting and uncertain cooperation of the public in reporting bands are biases which do not affect data from returns. They should, therefore, measure mortality more accurately than do recoveries (Austin, *op cit.*). However, in calculating mortality rates from returns, the assumption is made that all birds not recaptured in later years are dead. Obviously, it would be nearly impossible to catch all surviving birds even though they returned to the same area. Austin *(op. cit.)* suggested that this does not affect the rate of decline of birds returning in subsequent years, which can be estimated. But, he failed to show that first-year mortality cannot be calculated from returns. Because all calculations, after the first year, are based entirely on birds that return, cohorts are combined into a theoretical population. The first-year calculation involves the relationship of the *true* banded population to the first-year returning birds that are a segment of the *theoretical* population. Therefore, the mortality rate derived from this calculation is incorrect.

Moreover, since juvenile doves have a higher mortality than adults and are less faithful to home, the calculated first-year mortality rate,

TABLE 2. LIFE TABLES BASED ON RETURNS, 1953-1958. ALL BIRDS BANDED AND RETURNED ON SMALL AREA

Year of return after banding	No. alive at start of interval	Birds banded and available	% alive at start of each interval	% dying in each interval	Annual mortality rate
0-1	1552	1552	100.0	89.7	89.7%
1-2	160	1552	10.3	4.9	47.5%
2-3	70	1295	5.4	2.9	53.7%
3-4	21	844	2.5	1.2	48.0%
4-5	5	390	1.3	.8	61.5%
5-6	1	205	.5	.5	100.0%

Mean annual mortality rate 0-6 years = 83.3%*
Mean annual mortality rate 1-6 years = 51.5%

*Using Lack's formula: $M = \dfrac{D_1 + D_2 + D_3 \ldots + D_n}{D_1 + 2D_2 + 3D_3 \ldots nD_n}$

Where "M" is the mean annual mortality rate
D_n is the number dying in a given year.

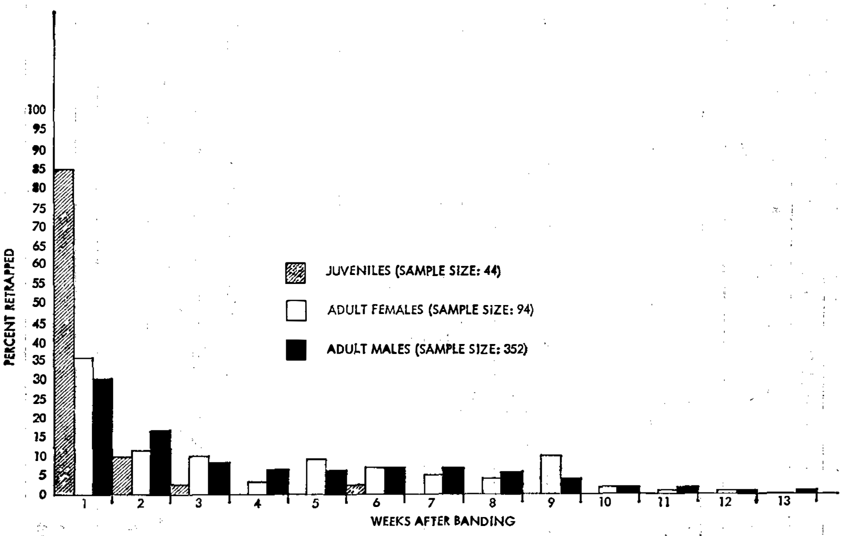

Figure 4. Observations of dyed doves in relation to time of dyeing.

based on returns, is higher than the true rate. Any inefficiency in trapping also causes the calculated rate to be too high. The first-year mortality rate of 89.7 percent (Table 2), then, reflects not only mortality of young, but inaccuracy of homing and trapping inefficiency as well. The mean annual mortality rate of 51.5 percent after the first year is a reasonable estimate of the mortality rate because, as discussed below, a high percentage of the surviving adult segment of the population homes accurately to the trapping area. This figure is very similar to the Missouri average adult mortality rate of 52 percent based on recoveries and makes the calculation seem more plausible.

LOCAL MOVEMENT

As long local flights of doves could have influenced the data on accuracy of migrational homing, it was thought desirable to determine the extent of local movement during the summer. Traps were so located that the greatest distance at which a bird could be recaptured was five miles. The data are strongly biased in favor of doves which returned close to the point of original capture, because, although area increases greatly as one progresses from the point of capture, the numbers of traps do not increase proportionately.

Table 3 compares all birds that were retrapped once with those that were retrapped more than once. In the latter group, the greatest

TABLE 3. DISTANCE MOVED BY DOVES RETRAPPED IN 1957 AND 1958—ALL AGES AND SEXES

Retrapped once	Distance Retrapped From First Capture Point (Miles)															
	0	¼	½	¾	1	1¼	1½	1¾	2	2¼	2½	2¾	3	3¼	3½	Total
Number Retrapped	115	46	15	9	11	7	3	3	1	0	0	0	1	1		212
Cumulative % Retrapped	54	76	83	87	92	95	96.5	98	98.5	..	..	..	99	99.5		
Retrapped More than Once																
Number Retrapped	38	19	18	8	6	6	1	1	0	1						98
Cumulative % Retrapped	39	58	76	84	90	96	97	98	..	99						

TABLE 4. COMPARISON OF DISTANCE MOVED BY ADULT MALES AND FEMALES RETRAPPED ONCE IN 1957 AND 1958

	Distance Retrapped From First Capture Point (Miles)															
Males	0	¼	½	¾	1	1¼	1½	1¾	2	2¼	2½	2¾	3	3¼	3½	Total
Number Retrapped	78	33	12	7	8	2	2	0	0	0	0	0	0	1	1	144
Cumulative % Retrapped	54	77	85	90	96	97.5	99	..	..	..	..	..	..	99.5	100	
Females																
Number Retrapped	28	12	3	3	2	4	1	0	1							54
Cumulative % Retrapped	52	74	80	86	90	97	99	..	101							

TABLE 5. COMPARISON OF DISTANCES MOVED BY ADULT MALES AND FEMALES RETRAPPED MORE THAN ONCE IN 1957 AND 1958

	Distance Moved from Farthest Capture Point (Miles)															
Males	0	¼	½	¾	1	1¼	1½	1¾	2	2¼	2½	2¾	3	3¼	3½	Total
Number Retrapped	26	13	14	7	3	6	0	0	0	1						70
Cumulative % Retrapped	37	56	76	88	90	99	..	..	..	100						
Females																
Number Retrapped	6	5	3	1	2	0	1	1								19
Cumulative % Retrapped	32	58	74	79	90	..	95	100								

distance between any two trappings was used as the distance moved regardless of the number of times retrapped.

At least 90 percent of all birds were retrapped no farther than one mile from the original capture point. Those that were retrapped more than once were recorded less often at the original trapping site. This is because only the maximum distance is tabulated, and captures at the original site do not appear if the dove was also retrapped elsewhere.

A comparison of movements of adult males and females (Tables 4 and 5) reveals only slight differences between the sexes. The greatest distance traveled was by an adult male that moved three and one-fourth miles.

Juveniles were retrapped very few times. This was thought to be due to rapid dispersal from the natal area as previously discussed.

In spite of a few long local flights, the data (Table 3) indicate that adult doves were remarkably sedentary during the summer: over half were recaptured at the point of original capture, and 92 percent no farther than one mile away. The large percentage of birds retrapped at the same location is strong evidence that low mobility was the rule because trap density did not affect this figure. The significance of the low mobility shown by retrappings is in the interpretation of our return records, for this low mobility implies that a dove returning to the same trap site in consecutive years is actually returning to a very restricted area.

MIGRATIONAL HOMING

In his review of homing, von Haartman (1949) concluded that juveniles of most songbird species are not so faithful to home as adults and, furthermore, that adult males generally disperse over a smaller area than do females. This differs from ducks in which the female shows a pin-point homing to a definite area in spring, and the male follows the hen to the place of her return, and only coincidentally arrives at the same place he was the year before (Sowls, 1955).

In order to determine accuracy of homing in the present study, traps were located one-fourth of a mile apart along roadways and the exact location of return and the distance from the original capture point were recorded. The low mobility demonstrated in the previous section allows us to assume that original points of capture were near the nesting sites and could be used as points of origin.

Distances between return sites and banding points for birds re-

TABLE 6. DISTANCES BETWEEN RETURN SITES AND BANDING POINTS FOR DOVES RETURNING IN 1957 AND 1958

	Distance Between Return Site and Banding Point (Miles)															
All Ages and Sexes	0	¼	½	¾	1	1¼	1½	1¾	2	2¼	2½	2¾	3	3¼	3½	Total
Number Returned	57	57	33	29	13	8	3	9	2	0	3	1	1	1	0	211
Cumulative % returned	27	51	67	81	87	91	92	96	97	..	98	98.5	99	99.5	0	
Adult Males																
Number Returned	36	38	26	19	5	5	3	9	0	0	1					142
Cumulative % Returned	25	52	70	83	87	91	93	99	..	..	100					
Adult Females																
Number Returned	15	13	7	9	6	3	0	0	2	0	0	1	0	1		57
Cumulative % Returned	26	49	61	77	88	93	..	..	97	..	..	99	..	101		
Juveniles																
Number Returned	6	0	0	1	2	0	0	0	0	0	2	0	1			12
Cumulative % Returned	50	..	..	58	75	..	..	..	..	..	92	..	100			

TABLE 7. RELATIONSHIP OF OBSERVED RETURNS TO EXPECTED RETURNS, 1953-1958

Sex	A Number Banded	B Survival Rate	C Number Survived to Return	D Percentage Capture of Returning Doves	E Expected Recapture of Surviving Returns	F Observed Returns	G Percent of Expected that Returned
Adult Male	951	48%	456	38.5%	166	169	101%
Adult Female	652	48%	313	24.0%	75	69	92%

turning in 1957 and 1958 are shown in Table 6. The bias that applied to the retrap data also applies to returns and again should be kept in mind.

Many returning doves were remarkably accurate in migrational homing. Of 211 returns 87 percent were recaptured within a mile of their points of original capture. Slightly more than one-fourth returned to the exact spot of original capture. Here again there is no bias because of trapping density, since the birds returned to the same trap site where taken the previous year. The greatest distance recorded was for an adult female returning three and one-fourth miles from the point of original capture. There was little sex difference in accuracy of homing, approximately 88 percent of both sexes returned to within a mile of the original trapping site. Too few juveniles returned to justify conclusions as to their accuracy of homing.

RETURN RATES

By correcting for mortality and the failure to find some returning birds, Sowls (1955) determined that essentially all of his banded adult pintail hens that were alive after winter returned to nest on the study area in subsequent years. A similar method was used in the present study to determine the return rate of mourning doves surviving the winter. In five years, 951 adult males, 652 adult females, and 411 juveniles of both sexes were banded at Fountain Grove Wildlife Area. From this sample, 169 adult males, 69 adult females and 13 juveniles returned and were recaptured (Table 7, Column F). As shown earlier, the mean annual mortality rate for adult doves is approximately 52 percent. The survival rate for a population equals one minus the mortality rate, hence it is seen that the mean annual survival rate for adults is 48 percent, assuming no sex difference (Table 7, Column B). The number of birds that survived to return was calculated by multiplying the survival rates by the five-year banding figures (Table 7, Column C).

It was suspected that the trapping method used in the present study was not efficient and only a small sample of the population on the area was taken. A modified version of the Lincoln index was used to determine the dove population on the trapping area. Because adult doves are relatively immobile during the summer, it was assumed that all adults were in the study area until termination of trapping in mid-September.

Under this assumption, the total adult population of each sex was calculated according to the formula

$\frac{A}{P} = \frac{R}{R+B}$ where:

A = total adults (♂ or ♀) banded in June and July

P = total population (by sex)

R = number of retrapped adults (♂ or ♀) in August and September

B = total unbanded adults (♂ or ♀) caught in August and September

Substituting,

♂♂: $\frac{514}{P} = \frac{73}{73+185}$

P = 1817 ♂ doves

♀♀: $\frac{269}{P} = \frac{26}{26+142}$

P = 1738 ♀ doves

then,

Percentage of total population trapped $= \frac{A+B}{P} \times 100$, or

$\frac{514+185}{1817} \times 100 = 38.5\%$ (♂♂) $\frac{269+142}{1738} \times 100 = 24\%$ (♀♀)

Thus, an estimated 38.5 percent of the male population and 24 percent of the female population was trapped. If we assume that this same percentage of returning birds was trapped, we can calculate an expected number of returns among adult males and adult females (Table 7, Column E). The discrepancies between the expected adult returns and the actual numbers of returns presumably represent birds which survived but did not return to the trapping area, and the ratio of actual to expected returns (Table 7, Column G) is a measure of accuracy of migrational homing in the sex classes. According to these calculations, virtually all surviving adult males return to nest in the area of previous nesting. Although there is a smaller percentage of females returning, the difference is not great. It is seen, then, that most surviving adult doves return to the restricted area of the previous year's nesting.

The calculation for juveniles cannot be made because their is a changing population, and thus does not permit Lincoln index computations. However, so few returned (13 of 411 banded), that it is assumed that homing occurs principally to first nest sites and rarely to the natal sites.

SUMMARY

1. This paper reports the migrational homing and local movements of mourning doves at a north central Missouri banding area. In-

cluded also is a comparison of mortality rates computed from returns to this study area and from statewide recoveries.

2. Beginning in 1953, Missouri Conservation Commission personnel performed trapping in an irregular area about one mile in diameter. This diameter was expanded to about five miles during the summer of 1957 and 1958. Approximately fifty-five traps were set along roadways at intervals of one-fourth mile.
3. To study local movements young birds were color-marked by dyeing and released at the point of capture.
4. The sex ratio among trapped adults was 178 males per 100 females in 1957, and 161:100 in 1958. The preponderance of males was thought to be due to sex differences in incubation schedules.
5. Juveniles progressively increased each month in the trapped sample until they equalled the number of adults in September.
6. The mean annual mortality rate after the first year was calculated from return data and found to be 51.5 percent. This figure closely agrees with the 52% estimated by calculation from Missouri recoveries.
7. Each summer, at least 90 percent of all birds were retrapped within one mile of the original capture point. Because doves are relatively sedentary during the summer, it seems unlikely that long local flights were made frequently enough to affect the data on migrational homing.
8. Accuracy of migrational homing was determined by comparing the location of return to the original capture point. Of 211 returns, 87 percent were recaptured within a mile of their original capture point, and over one-fourth returned to the exact spot of original capture. There was little sex difference in accuracy of homing. Too few juveniles returned to make conclusions as to their accuracy of homing.
9. By correcting for mortality and trapping inefficiency, it was estimated that all surviving adult males and 92 percent of surviving adult females returned to nest in the area of previous nesting.

LITERATURE CITED

Austin, O. L., Jr.
1951. The mourning dove on Cape Cod. Bird-Banding, 22:149-174.

Hickey, J. J.
1952. Survival studies of banded birds. Special Sci. Rept.: Wildl. No. 15. Fish and Wildlife Service Washington, D. C. 177 pp.

Mourning Dove Investigations
1957. Tech. Bull. No. 1. Southeastern Association of Game and Fish Commissioners. Columbia, S. C. 166 pp.

Pearson, A. M. and G. C. Moore
1940. Feathers may reveal age of mourning doves. Ala. Cons., 1(1):9-10.

Petrides, G. A.
1950. Notes on determination of sex and age in the woodcock and mourning dove. Auk, 67:357-360.

Sowls, L. K.
1955. Prairie ducks, a study of their behavior, ecology, and management. Stackpole, Harrisburg. 193 pp.

von Haartman, L.
1949. Der Trauerfliegenschnäpper. Acta Zool. Fenn. 56, Helsingfors. 104 pp.
Wight, H. M.
1956. A field technique for bursal inspection of mourning doves. J. Wildl. Mgmt., 20:94-95.
1957. Banding of mourning doves. Unpub. P-R Rept., Mo. 13-R, Mo. Cons. Comm., Columbia, Mo. 15 pp.
Winston, F. A.
1954. Status, movement and management of the mourning dove in Florida. Tech. Bull. No. 2, Fed. Aid Proj. W-22-R. Fla. Game and Freshwater Fish Comm. 86 pp.

DISCUSSION

MR. PETERLE [Columbus, O.] Do you have any generalized conclusions for the high proportion of males in your trapping?

MR. WIGHT: There is a very good reason why we made no generalized conclusion on sex ratio. They are highly biased in favor of males. The males are on the nest during the daytime. The females are on the nest basically at night. However, the male, after the sun rises in the morning gets out and feeds as fast as he can to get back to the nest to relieve the female, and he is much more trap-vulnerable than the females. Therefore, we have a very disproportionate sex ratio in favoring the males.

This also can be seen in collecting doves during the summertime, and therefore either trapping or collecting does not yield sex ratio data.

MR. W. H. KEIL [Laurel, Md.]: I would like to ask if he would explain briefly the use of Lincoln index to estimate the dove population on the study area. It seems to me in using the Lincoln index to estimate the efficiency of trapping the adults, you might be underestimating the population and thereby overestimating the degree or percentage of migrational homing. I think that in doves as well as a lot of other species, we have to deal with habitual repeaters of trap-happy birds, and once a bird is trapped it seems likely to me that he is more likely to be retrapped than a bird that has not been caught, and in using the Lincoln index in this way I think you might be prone to underestimate the population.

MR. WIGHT: We used two time segments, the trapping in the months of June and July, and the trapping in August and September as our two variables. We are assuming our adult population is relatively stable during this period, and there is little mortality in this segment during this period.

I would be the last one to categorically state that this represents an accurate measurement of our dove population on this study area. I think everybody who has worked with the Lincoln index computations realizes their limitations. The opportunity presented itself, however, in this work at least to carry this computation out and determine something about the magnitude of the return, and I hope, at least, that all readers of this paper will understand that you are dealing with a pretty controversial technique in determining populations with Lincoln index. At the same time, I think we would have been remiss in not milking this data for everything we could, and I certainly don't apologize for utilizing that technique.

MR. KEIL: I think the study is an outstanding one and has contributed a large amount of good information. I understand that Missouri is investigating winter flocks of mourning doves, and if it can be established that perhaps some segments of the population are nonmigratory, this would also have a bearing on the degree of homing of the birds to their nesting areas. Perhaps you would like to expand on that.

MR. WIGHT: We are studying this problem. Dr. Baskett and we have had a very good working arrangement. I keep his students employed in the summer, and we figure up problems for them to do, and they can write a master thesis on it, and one gentleman now working on this problem is considering just exactly what a winter flock in Missouri represents. Fortunately we have this lovely backlog of data right on our permanent trapping site, in which there are flocks appearing every winter He has been very actively collecting in this area and some of the birds he is collecting are banded birds from the summertime work.

I hesitate to expand too much on this subject because I am sure that his findings are going to be presented either here or in the Journal, I think this certainly is revolutionary to me to realize that a percentage of our summertime breeding population is right there during the wintertime.

DR. FRED H. WAGNER [Madison, Wis.]: Do you have any evidence at all or even an impression of the return pattern of the juveniles?

MR. WIGHT: We get a very small complement back to the trapping station. We have other banding data that indicates that our juveniles do return to Missouri. Maybe I make that statement a little too strongly. I don't know whether this is a routine thing or an accidental thing because our recovery data on immatures is principally from areas to the south of us and from hunting. I don't have a clear-cut picture in my own mind what the fate of those birds is in the return of their surviving juveniles to the breeding ground.

IMPORTANCE OF FOOD TO COTTONTAIL WINTER MORTALITY[1]

REXFORD D. LORD, JR. AND DAVID A. CASTEEL

Illinois Natural History Survey and Department of Conservation, Urbana, Illinois

There has been a general belief that scarcity of food may be the primary although not the ultimate cause of the death of many animals in winter. The reasoning behind the belief has been that the necessity to maintain body temperature under conditions of severe cold and frequent scarcity of food puts excess strain on these animals. The implication is that the animals are weakened by lack of sufficient food and therefore become more susceptible to disease and easier prey for predators.

During the first year of a study of the population dynamics of the cottontail rabbit *(Sylvilagus floridanus mearnsi)* on two study areas in central Illinois, it was discovered that cottontails suffered a winter mortality of about 85 per cent. The ability to measure this mortality (Lord, 1959) made it possible subsequently to test whether the high winter mortality was here due to lack of natural foods by supplying food to the population on alternate years. A reduction of the mortality in winters when food was supplied would indicate that lack of sufficient food was either directly or indirectly responsible for the death of some rabbits.

METHODS

Two areas, each 100 acres in size, were selected for the study. Both areas were located in Robert Allerton Park, five miles south and

[1]A contribution of Federal Aid Project Number W-42-R.

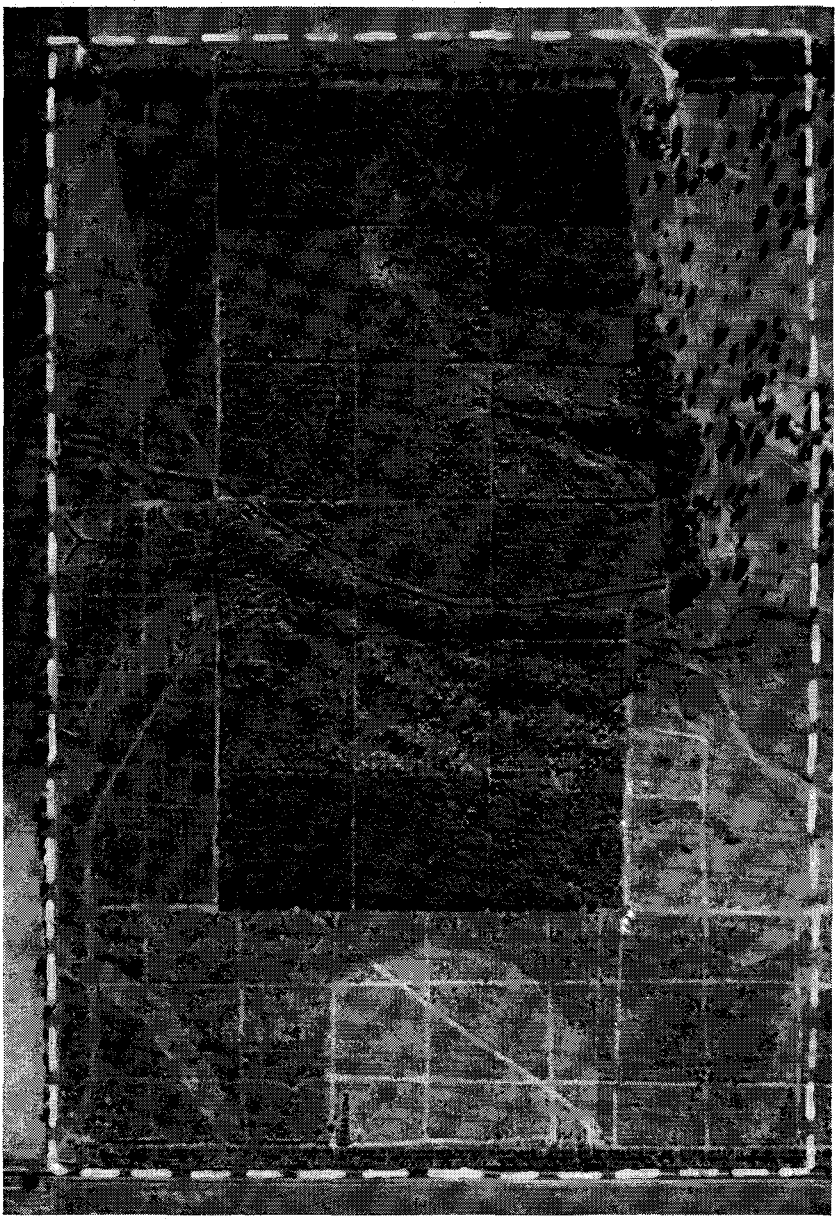

Figure 1. Aerial photograph of the 4-H study area.

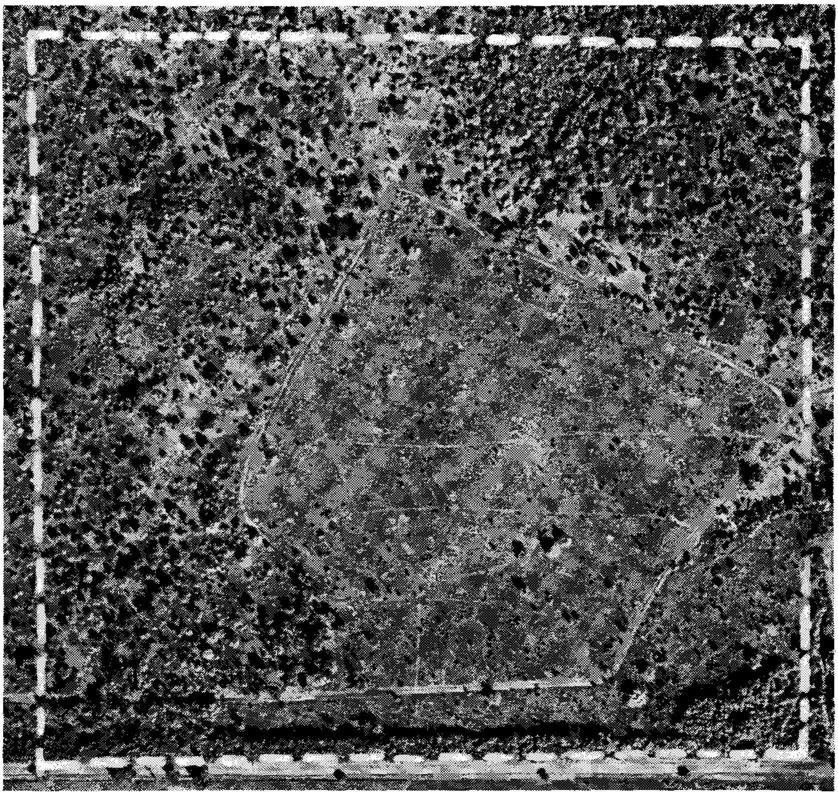

Figure 2. Aerial photograph of the sanctuary study area.

two and one-half miles west of Monticello in Piatt County, Illinois. One area was located on the grounds of the camp of the 4-H Clubs of Illinois and was named the 4-H area. The other area was located in a wildlife sanctuary and was named the sanctuary area.

The 4-H area has 18 2-acre blocks of evergreen and deciduous trees planted by the Forestry Department of the University of Illinois in 1947 and 1948 (Fig. 1). To the north and west of the blocks of trees are fields in which the cover is composed of herbaceous annuals interspersed with areas of bluegrass. Multiflora rose was planted as a hedge along the north and west boundaries of the area and along a contour line running north-south through the center of the area. The west boundary of the area has three rows of mixed pines planted as a windbreak. An old osage hedge bounds the east side of the area. The study area is bounded on the north and west by agricultural fields. To the east of the area is an airfield and to the south are a small woods, a lake, and the parade grounds of the 4-H camp.

The sanctuary area has a large field (approximately 60 acres) located in its center which is being managed as a prairie by the Zoology Department of the University of Illinois (Fig. 2). This field has a very mixed composition of bluegrass, blackberry, prairie grasses, and thistles. Surrounding the field the area is composed of an old field which is rapidly succeeding into forest. The ground cover is composed of bluegrass with scattered patches of blackberry bushes. The trees invading the area are mostly elm, soft maple, cherry, and red and shingle oak. To the south of the study area are agricultural fields; to the east, north, and west is more of the old field succeeding into forest.

The census technique and the technique for determining the winter mortality were the same as those described in detail elsewhere (Lord, 1959). Briefly, the areas were trapped with box traps in the fall and again in late winter of each year. The tails of the rabbits captured were dyed yellow in the fall and dark purple in the late winter. Each trapping period was followed by a census drive employing a large number of people. The purpose of the drive was to determine the ratio of dyed to undyed rabbits in the populations. Lincoln Index calculations were made to estimate the number of rabbits in the populations and the probability of dying was determined from the difference between the fall and late winter censuses. The probability of dying was also calculated from the ratio of rabbits with yellow tails to rabbits with dark purple tails seen during the late winter census drive.

Food was supplied to the rabbits on the study areas in 6-gallon lard cans (Fig. 3) which were in operation from mid-November to the end of February. A slot was cut in the bottom of each can and the metal flap folded in to permit a gravity flow of the food to the opening where the rabbits fed. The cans were placed on two 4″ x 4″ blocks of wood which kept the opening above most accumulations of snow. A feeder was placed on every other acre in a checkerboard pattern. Humid weather had a tendency to clog the feeders, requiring daily attention to them during such weather.

The food supplied to the rabbits was a balanced commercial rabbit food made by the Ralston-Purina Company (St. Louis, Mo.). The food contains all the nutrients needed to keep rabbits in good health. Several hundred cottontails kept in captivity remained healthy although supplied only with this rabbit food and water.

To determine usage by rabbits, the feeders were checked after fresh snowfalls (allowing a night for rabbit activity). Not all the

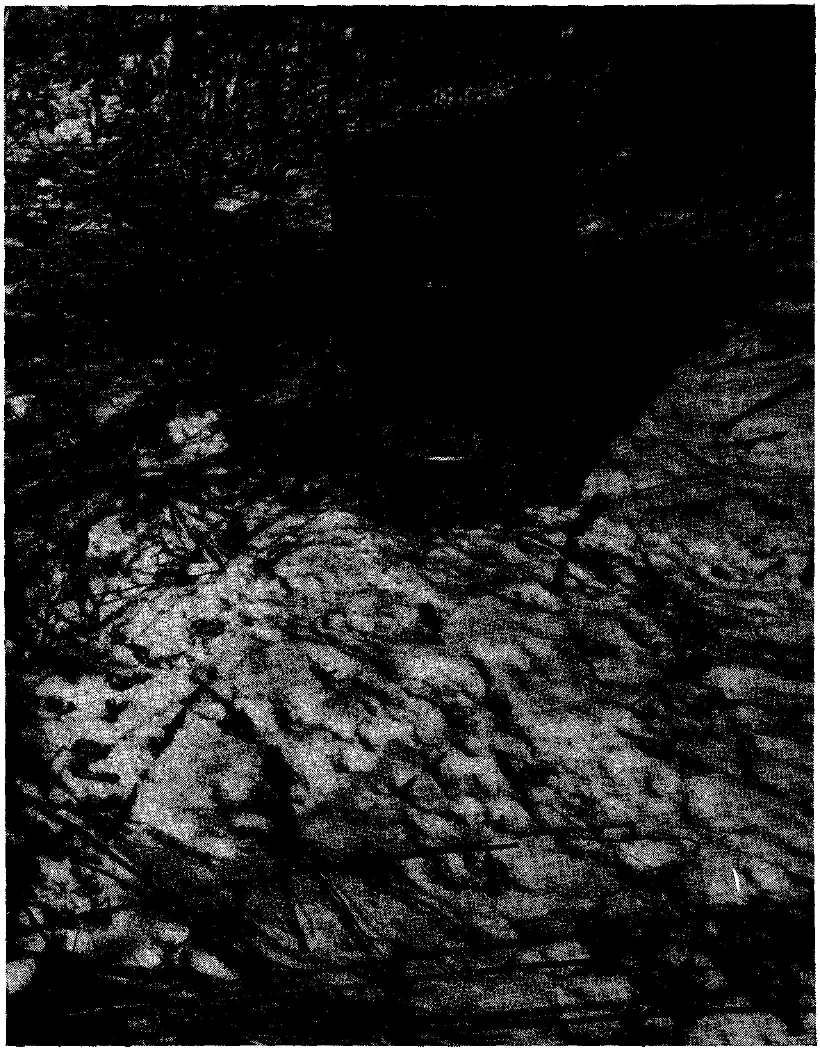

Figure 3. Lard-can rabbit feeder in operation. Note the rabbit tracks in the snow.

feeders were used by the rabbits, although there were none that did not serve as a source of food for mice. Thus when the amount of food consumed during the winter was calculated by subtracting the amount of food remaining from the amount originally supplied, it was possible to determine the average amount consumed by mice (and wastage due to clogging), by determining how much was missing from those cans never visited by rabbits.

The Illinois Water Survey figures for degree-days were used as a measure of the relative severity of the four winters. A degree-day is expressed as the number of degrees difference between 65 degrees F and the mean temperature for the day. Mean daily temperatures below 65 degrees give positive degree-day readings and means above 65 degrees give negative readings. That is, the higher the degree-day reading the colder the day. To compare the winters, the degree-day summaries for the four months of November, December, January, and February were totaled.

FINDINGS

Table 1 contains the population estimates, the probability of dying calculations, and the severity of the winter in degree-days for each winter of the study on both areas. This table also indicates which winters the rabbits were supplied with food on each area.

During the winter of 1957-58 the rabbits of the 4-H area consumed approximately 700 pounds of rabbit food, and the mice (and waste) accounted for an additional 60 pounds. On the sanctuary area during the winter of 1958-59 the rabbits and mice consumed about 728 pounds of rabbit food and deer consumed an additional 477 pounds of food. Molestation of the feeders by deer was never experienced on the 4-H area, principally because the deer did not regularly use that area. During the winter of 1959-60, approximately 509 pounds of rabbit food were consumed by both the rabbits and the mice on the 4-H area. The relative infrequency of snows during this winter made it impractical to try to calculate the amount of food consumed by mice. A total of approximately 2,474 pounds of rabbit food was

TABLE 1. RABBIT POPULATIONS ON THE STUDY AREAS

Winter	Population Estimate: Fall	S.E.	Population Estimate: Late Winter	S.E.	Probability of Dying: From Censuses	Probability of Dying: From Ratios	Total Degree-Days
4-H Study Area							
1956-57	333	56	47	14	0.86	0.84	3780
1957-58[1]	259	79	31	6	0.88	0.89	3953
1958-59	324	50	132	30	0.59	0.77	4152
1959-60[1]	239	27	56	14	0.77	0.81	3948
Sanctuary Study Area							
1956-57	......		102	23	......	......	
1957-58	238	61	63	9	0.74	0.31	
1958-59[1]	120	27	42	15	0.65	0.43	
1959-60	171	44	64	18	0.62	0.00	

[1]Winter when food was supplied for the rabbits.

consumed by animals on the study areas during the course of this project.

During the winter of 1957-58, 86 per cent of the feeders were visited by rabbits on the 4-H area. In 1958-59, 96 per cent of the feeders were visited by rabbits on the sanctuary area, and during the winter of 1959-60, 56 per cent of the feeders were visited on the 4-H area. The indicated low use of the feeders during this last winter is in part real and in part due to realitively few snows to check usage.

To determine if the food might benefit the rabbits by increasing their body weight, their average weights were calculated from the trapping and bag check data, and are listed in table 2.

DISCUSSION

It is apparent that the rabbits ate considerable quantities of the food, although in decreasing amounts for the three years that it was supplied. The feeders were regularly visited by rabbits if they were located in a position with favorable cover nearby. However, feeders which were located far out in the bluegrass fields were apparently never visited by rabbits.

Comparison of the censuses of the rabbit populations over the four years of the study on the 4-H area indicates a considerable degree of stability within seasons. The winter mortality of the rabbits was also very much the same for the four years of the study. The winter of 1958-59, a year when the rabbits were not fed on the 4-H area, showed the lowest winter mortality and this same winter was the most severe according to degree-days.

The agreement between the two methods for determining the probability of dying on the 4-H area was good, indicating a fair degree of accuracy. On the sanctuary area, however, the agreement between the two methods was poor, indicating a low degree of accuracy; probably due to the practical difficulties of performing census drives on this area.

The changes in the body weight of the rabbits showed no correlation with the years of feeding, and feeding did not appear to affect the large winter mortality of the rabbits. We therefore concluded that for these areas and the years of this study, food shortage was not an important factor (either directly or indirectly) in the winter mortality of the cottontail rabbits.

SUMMARY

The importance of food to the winter mortality of cottontail rabbits on two study areas in central Illinois was tested by supplying them with commercial rabbit food on alternate years. The winter mor-

TABLE 2. WINTER CHANGES IN BODY WEIGHT OF RABBITS

4-H Study Area

Winter	Mean Weight in Grams: Fall	Early Winter[1]	Late Winter	Per Cent Change: Fall-Early Winter	Early-Late Winter
1956-57	1087±241	1256±185	1192±127	+16%	−5%
1957-58[2]	931±315	1249±168	1248±109	+34%	−0%
1958-59	944±338	1169±218	1235±169	+24%	+6%
1959-60[2]	994±270	1226±200	1185±139	+23%	−3%
		Sanctuary Study Area		(Fall-Late Winter)	
1956-57	1140±277		1275±155	+12%	
1957-58	1168±249		1307±113	+12%	
1958-59[2]	1132±262		1276±106	+13%	
1959-60	1002±240		1209± 90	+21%	

[1]Early winter weights were taken during hunters' bag check and are therefore missing from the sanctuary where hunting was prohibited.
[2]Winters when rabbits were supplied with food.

tality was calculated by two methods with good agreement between the two methods on one area and poor agreement on the other area.

The rabbits ate considerable quantities of the food but received no benefit from it, either in the form of a gain in body weight or in reduction of the large winter mortality rate.

It was concluded that for the areas studied, lack of sufficient food was not an important factor, either directly or indirectly, in the winter mortality of the cottontail rabbits.

ACKNOWLEDGMENTS

We are indebted to most of the members of the Section of Wildlife Research of the Illinois Natural History Survey for participation in the census drives. Ernest E. Provost provided students of the University of Illinois for the census drives. Thomas G. Scott, Carl O. Mohr, Ralph E. Yeatter, and Barbara A. Chipman critically read and offered advice in the preparation of the manuscript.

LITERATURE CITED

Lord, Rexford D., Jr.
1959. A method for measuring mortality of cottontail rabbits in winter. J. Wildl. Mgmt. 23(2):241-243.

DISCUSSION

DISCUSSION LEADER DUSTMAN: That is a very interesting piece of field experimentation that Dr. Lord has conducted. I suspect if any strangers happen to penetrate this area where he had these rabbits with the tails dyed various colors, he would immediately go back home and change his brand of liquor.

DR. SHELDON [Massachusetts]: Will you give us a few more details on the census drive technique and how many rabbits were involved?

DR. LORD: The census drive technique was carried out by getting a large number of students, usually about 25, but we have one up as high as 50, and driving the blocks one at a time in a long line which moved forward, and then on each flank were two observers, and at the terminal end of the block were terminal observers back to back who counted the number of different-colored-tailed rabbits that crossed the mowed swath.

Then we moved from one lot to another. Now on the sanctuary area when we had the drive, the drivers themselves were the observers, and they called off what they saw to recorders, and this meant that when they came to thick areas, which were grown up with blackberry and so forth, they were slowed down, and yet these areas were where the most rabbits were, and thus we had an uneven observation of the sanctuary area. I think this is the reason. Now as to the numbers, there are approximately 300 rabbits in the fall on the 4-H study area, which drops to about 50 rabbits in late winter. On the sanctuary area, as I indicated, I don't trust the results.

MR. DOUGLAS JAMES [Fayetteville, Ark.]: Do I understand you didn't have controlled areas in the winters when you were testing feeding spots?

DR. LORD: The original design was each area would be a control one year and on the alternate year it would be the experimental area. Well, this didn't work out so that the control in this case is the area itself during some prior year or the following year.

MR. DOUGLAS JAMES: So your results could be the results of differing winter conditions that had no relation to food?

DR. LORD: They could be, and this might have been the reason, but the mortality was always the same each winter.

MR. DOUGLAS JAMES: I have a second question. What kind of trap did you use?

DR. LORD: I used all kinds. Have-a-heart traps which I find not quite as good in the wintertime as they are in the summer, and wooden box traps which aren't quite as good in the summer as they are in the winter.

CHAIRMAN SEUBERT: Dr. Lord has interesting information that when the rabbits were fed there was a drop in the gnawing of trees.

DR. LORD: What he mentioned is is actually the subject of another paper, but I found that during years when the rabbits were fed, there was a statistically significant drop in the gnawing of small deciduous trees, principally in those planted blocks on the 4-H area and on those blocks principally in red oak and osage.

MR. JOE L. HERRING [Monroe, La.]: What type of bait did you use?

DR. LORD: I used Purina Rabbit Chow.

MR. HERRING: That is all you used? Was the area hunted? The sanctuary wasn't, but was the other area?

DR. LORD: Yes, it was hunted, and this is the subject of still another paper with some rather interesting results. During each of the first three years of the study, the hunters harvested about 34 per cent of the fall population. It was very constant. Now during this last year it rose to 39 per cent; so since it was constant, the natural mortality being the complement of the 34 per cent was the thing that we were really interested in when it came to the feeding winter mortality and so forth.

MR. CLARENCE NEWTON [Lincoln, Nebr.]: I would like to know something about the snow depths you have in the winter. In Nebraska that type of feeder would have to be anywhere from 2 to 3 feet above the ground in some places to make the food available to rabbits.

DR. LORD: It is obvious Illinois does not have the snow that Nebraska has. We did have some snows that were deep enough to cover the opening of the feeder, but the rabbits dug down through the snows and in Illinois these snows don't last long.

DR. ARNOLD HAUGEN [Ames, Iowa]: I wonder if you did any work to find what per cent of the rabbit population you might harvest. In other words, did you harvest anywhere near what you should or could have taken from your area?

DR. LORD: We harvested as much as we could. I put so much hunting pressure on this area that is was really phenomenal. I personally put a lot of time in hunting, and my co-author, David Casteel put a tremendous amount of time in hunting. We had all of our hunters under our control. That is, they were employees of the Robert Allterton Park, and they did quite a bit of hunting themselves. They used dogs. All in all there was very intensive hunting. We could not possibly have killed any more rabbits than what we killed other than starting the hunting season earlier. Then I think we might have.

I know that the rabbits were dying of natural causes during the same time we were hunting. I know this because I picked up several rabbits in apparently good condition. That is, there was nothing obviously wrong with them. I thought they were cripples that had escaped the hunters. I brought them back to the laboratory and X-rayed them for shot and found no shot. Then they were turned over to the veterinarian people of the University of Illinois for pathology examinations. They found nothing.

DR. HAUGEN: I did some experimental feeding on quail in Northern Alabama several years ago. In that case, at least, we didn't do any good for the population.

MR. TONY J. PETERLE [Columbus, Ohio]: We have a student who just completed a master's thesis wherein he develops the idea that juveniles are about twice as vulnerable to trapping as adults. In your fall trapping, in your trapping as we think from studies of enclosed populations, you are marking about twice the ratio of juveniles. Consequently your mortality estimates will be on these juveniles. Do you compute your estimates separate for the various age classes?

DR. LORD: How do you determine the age of a rabbit that is of mature size which you can't kill and look at the humerus? I guess you could X-ray it. I didn't X-ray it, so when they attained mature size I could not tell whether they were juveniles or adults, so the mortality was not measured by age classes.

MR. PETERLE: You feel the mortality would be higher in young animals than the adult?

DR. LORD: Yes, I do.

DR. VINCENT SCHULTZ [Silver Spring, Md.]: In regard to the question that was made to Rex about what control he had, this is a natural statistician-injected comment. Rex has designed an excellent experiment. This is what is called a switchback design in which the area itself is used as its own control. The only objections you have is that he didn't have any replication. For instance, the other area with switchback in the opposite order of the study area. Of course, you can't replicate for where we don't have funds and personnel in the wildlife field. It was an excellent opportunity to set up an area because you have the control.

PESTICIDAL RESIDUES IN ANIMAL TISSUES

JAMES B. DEWITT, CALVIN M. MENZIE, VYTO A. ADOMAITIS AND WILLIAM L. REICHEL

Bureau of Sport Fisheries and Wildlife, Laurel, Maryland

The rapid growth of the pesticide industry in recent years has been accompanied by increased emphasis upon large-scale programs for suppression of insect pests. Operations such as those against Dutch elm disease, Japanese beetles, imported fire ants and forest insects are not limited to croplands or scattered plots which might be treated by individual landowners, but annually result in the application of insecticides to many thousands of acres of wildlife habitats. Birds, fish and other wild animals are placed in intimate contact with these toxic materials, or may ingest them with their food.

Accurate appraisal of the total effects of this exposure is difficult. Direct or immediate damage to wildlife resources can be determined through field observations, and has been found in a number of cases. Heavy losses of young salmon followed applications of DDT for control of forest insects in New Brunswick (Kerswill and Elson, 1955), and other fish losses were attributed to use of dieldrin for control of sandflies in Florida (Harrington and Bidlingmayer, 1958). Damage to birds and mammals resulted from applications of dieldrin for control of Japanese beetles in Illinois (Scott, *et al.,* 1959), and from use of heptachlor for eradication of imported fire ants in several southeastern States (Baker, 1958; Glasgow, 1958; Lay, 1958; Newsom, 1958).

Indirect, or delayed effects have been reported in other cases. Many of the chlorinated insecticides leave persistent residues, and are cumulative in action. Repeated or continued exposure to small quantities of these materials results in accumulation of pesticidal residues in tissues, and may cause death at any time that tissue storage exceeds a critical value. Earthworms and other food organisms have been shown to concentrate toxicants in their tissues, and losses of robins and grebes have been attributed to consumption of these contaminated foods (Barker, 1958; Hunt and Bischoff, 1960).

A recurrent problem in determining effects of insecticides upon wildlife has been the difficulty of obtaining positive evidence that the observed mortality of birds and other animals was the direct or indirect result of exposure to the toxicants. Chemical analysis of tissues has been made in a few cases (Mitchell, *et al.,* 1953; Barker, 1958; Scott, *et al.,* 1959; Hunt and Bischoff, 1960), but data have been lacking on the quantities of residues stored by different species under conditions of lethal and sublethal exposure. In the absence of this information, the finding of residues in tissues does little more than confirm the fact that the animal had been exposed to the possibility of poisoning.

Studies to provide portions of this needed background data are now in progress at the Patuxent Wildlife Research Center near Laurel, Maryland. Captive birds and mammals have been maintained on diets furnishing lethal or sublethal quantities of insecticides, and tissues from these laboratory specimens are being analyzed. Concurrent analyses are being made on specimens found dead or collected by shooting or trapping in areas which have been treated with insecticides.

The cooperation of Dr. Maurice F. Baker, Dr. Leslie L. Glasgow, Daniel W. Lay, Ralph H. Allen and Donald D. Strode, who collected these specimens, is gratefully acknowledged.

METHODS

Feeding Tests: Young and adult bobwhite quail and ringneck pheasants were divided into groups of approximately 25 birds each and were allowed *ad libitum* access to diets containing small percentages of insecticides. Initial tests with each compound were conducted at high levels of pesticide intake to provide information on quantities producing acute poisoning (death within 10 days of initial exposure), whereas subsequent tests were conducted at levels which were expected to cause death from chronic poisoning within 100 days, or to permit survival for extended periods. All tests were conducted in replicate.

Similar tests with starlings, mallard ducks, and laboratory rats have been conducted to determine the toxicity of heptachlor to these species.

Analytical Procedures: Specimens were preserved by freezing when it was impracticable to analyze them immediately after receipt in the laboratory. Tissues used for analysis included the entire body of small birds, except for the feet, beak and feathers. Larger birds and animals were dissected, and samples of muscle, brain, kidney, liver and heart were analyzed. Tissues were dried under reduced pressure or over sulfuric acid, weighed, ground, and extracted with petroleum ether. Extracts were concentrated in a gentle stream of air, with care being taken to avoid overheating or too rapid evaporation.

DDT extracts were purified and analyzed according to procedures prescribed by the Association of Official Agricultural Chemists (1950). Chlordan, heptachlor and dieldrin extracts were purified by washing with a 2:1 mixture of concentrated and fuming sulfuric acids, and chromatographed according to the method of Gannon and Bigger (1958). Determination of chlordan and heptachlor was made according to the method of Ordas, *et al.* (1956), and dieldrin was determined according to the procedures described by O'Donnell, *et al.* (1955).

RESULTS AND DISCUSSION

Toxicities of 23 insecticides have been determined in the feeding tests (Table 1). Aldrin and endrin were the most toxic compounds tested, and were unique in that the lethal dosages for acute and chronic poisoning were approximately equal. With all other materials tested, the quantities required to produce death from chronic poisoning were appreciably greater than those required to produce immediate kills.

The results of the feeding tests showed that there were wide variations between individuals and between species in susceptibility to insecticides. Some pheasants developed typical symptoms of chlorinated hydrocarbon poisoning, and died, after ingesting less than 40 milligrams of heptachlor per kilogram of body weight; others ingested more than 1,600 milligrams per kilogram before succumbing. In

TABLE 1. TOXICITY OF INSECTICIDES TO CAPTIVE BOBWHITE QUAIL AND RINGNECK PHEASANTS IN TESTS AT PATUXENT WILDLIFE RESEARCH CENTER

Compound	Approximate Lethal Dose to 50 Per Cent or More of Subjects (milligram per kilogram) (Chronic Poisoning)		Maximum Concentration in Diet Permitting Normal Survival (p.p.m.)	
	Quail	*Pheasants*	*Quail*	*Pheasants*
Aldrin	4	14	0.5	5
Endrin	5	14	0.5	1
Dieldrin	35	50	5	20
Phosdrin	90	....	<1,000*	....
Heptachlor	125	150-400	25	25
Chlordan	250	500	50	50
Lindane	200***	400***	100	100
BHC	250	450	50	>100**
Malathion	400	1,600	50	500
Co-Ral	400	....	<1,000*	....
Toxaphene	500	450	200	100
DDT	500	300	200	50
Kepone	500	<1,000	<200	<500*
Strobane	500	1,600	<500*	<500*
Dylox	500	2,500	100	500
Chlorthion	700	....	<500*	....
Disyston	800	....	<1,000*	....
Rhothane	....	<2,800	....	<5,000*
Kelthane	......	<3,200	....	<2,000
Delnav	3,000	15,000	1,000	2,500
Guthion	5,000	6,000	100	500
Perthane	9,000	>9,000	5,000	<5,000*
Methoxychlor	22,000	25,000	2,500	1,000
Sevin	....	>40,000	....	>5,000**

* Not tested at lower levels.
** Not tested at higher levels.
*** Inadequate number of birds.

TABLE 2. INSECTICIDAL RESIDUES IN TISSUES OF LABORATORY SPECIMENS

		Residues in Tissues (p.p.m.)					
		DDT		Chlordan		Heptachlor Epoxide	
Species	Tissue Analyzed	Sacrificed[1]	Died[2]	Sacrificed[1]	Died[2]	Sacrificed[1]	Died[2]
Bobwhite	Entire Carcass	8.3	57.0	6.3	21.6	1.4	22.2
Quail	Breast Muscle	....	34.5	......	......	......	......
Ringneck	Breast Muscle	3.6	23.9	16.0	73.6	Trace	0.6
Pheasants	Brain	....	......	155.0	344.0	0	2.1
Laboratory	Heart	....	......	......	......	20.0	40.6
Rats[3]	Liver	....	......	......	......	9.0	17.0
	Kidney	....	......	......	......	32.0	57.1
	Brain	....	......	......	......	34.2	79.0

[1]Sacrificed after exposure to sublethal dosages of toxicant.
[2]Died of acute or chronic poisoning.
[3]Holtzman strain.

general, adult birds were more resistant than young, although male pheasants were highly susceptible during the breeding season. Differences in species susceptibility are illustrated by the results obtained with heptachlor, where the lethal doses (in milligrams per kilogram) were: starlings—25; rats—75; quail—125; pheasants—300; mallard ducks—425.

The primary objective of these studies was to determine quantities of toxicant stored in tissues of different species under varying degrees of exposure, and to ascertain whether chemical analyses could be used as diagnostic tools in determining cause of death of field specimens. DDT, chlordan, and heptachlor were selected for extensive study, since these compounds are representative of a large class of materials used in wildlife habitats. Analyses of laboratory specimens for other compounds are being conducted as opportunity permits, and a number of field specimens have been analyzed for dieldrin.

Quantities of toxicant stored in tissues were roughly proportional to the severity of exposure (Table 2), and concentrations found in animals which died of acute or chronic poisoning were appreciably greater than those found in animals which were sacrificed after varying degrees of sublethal exposure. Quail which were sacrificed after 150 days on diets containing 50, 100 or 250 p.p.m. of DDT stored 1.6, 4.1, and 19.8 p.p.m. of this compound in body tissues; but birds which died during these tests contained 34.5 p.p.m. in breast muscle, 52.4 p.p.m. in the gastro-intestinal tract, and 57.0 p.p.m. in the entire carcass. Pheasants sacrificed after 150 days on diets containing 50 p.p.m. of DDT had 3.6 p.p.m. in breast muscle, but birds which died of acute or chronic poisoning contained 23.9 p.p.m. in this tissue. The results of these tests appeared to justify the conclusion that the finding of 30 to 40 p.p.m. of DDT in breast muscle of quail, or 20 to 30 p.p.m. in breast muscle of pheasants indicated that the birds had died as the direct result of exposure to this compound, or that they had ingested a quantity that could be expected to cause death.

There were marked individual differences in susceptibility to chlordan and heptachlor, and there were similarly wide variations in quantities of insecticidal residues in tissues of animals exposed to these compounds. Concentrations of chlordan in bodies of quail sacrificed after 150 or more days' exposure ranged from 1.0 to 10.3 p.p.m., but birds which died of chlordan poisoning contained from 4.3 to 49.2 p.p.m. Quantities of chlordan in breast muscle of pheasants ranged from 0 to 21.3 p.p.m. in cases of sublethal exposure, and from 1.0 to 250.0 p.p.m. in cases of acute or chronic poisoning. Concentrations in pheasant brains ranged from 11.0 to 431 p.p.m. in sublethal, and from 0 to 950 p.p.m. in lethal exposure. Despite these pronounced individual variations, the average values for birds which died of acute or chronic poisoning were appreciably higher than those for birds which were sacrificed after sublethal exposure.

No analyses were made for the metabolites of DDT or chlordan. However, heptachlor is readily converted to its epoxide, and is stored in this form in animal tissues. Tests upon several hundred laboratory specimens showed that small quantities (1 to 2 p.p.m.) of the unchanged compound were found in some cases of acute poisoning, but that little or none was found in cases of sublethal exposure or in chronic poisoning. Storage of heptachlor epoxide varied over wide ranges, but the concentrations in tissues appeared to be proportional not only to the severity of exposure, but also to the time required for ingestion of a lethal dose. Quail which died of acute poisoning within 8 to 10 days of the initial exposure contained from 4 to 11 p.p.m. of the epoxide in the entire carcass, but birds which died after 20 or more days' exposure contained as much as 45 p.p.m. Rats which ingested a lethal dose within an 8-day period contained 3.2 p.p.m. of epoxide in heart, 7.7 p.p.m. in liver, 12.1 p.p.m. in kidney, and 53.1 p.p.m. in brain tissue, but animals which died after 12 or more days' exposure contained 95.5 p.p.m. in heart, 22.3 p.p.m. in liver, 41.5 p.p.m. in kidneys, and 12.0 p.p.m. in brain. Relatively little heptachlor epoxide appeared in tissues of quail or pheasants which were sacrificed after varying degrees of sublethal exposure

While these laboratory studies were in progress, extensive areas in the Gulf States were treated with heptachlor or dieldrin for eradication of imported fire ants. Heavy losses of birds and other animals were observed in some of the treated areas, and specimens from Texas, Louisiana, Alabama, Georgia and Florida were submitted for analysis. More than 98 per cent of these specimens contained dieldrin, heptachlor or heptachlor epoxide, in amounts ranging from a trace in the one yellow-throated warbler examined to 20 p.p.m. in white-throated sparrows and still higher concentrations in other species (Table 3).

No data are available on the quantities of toxicant ingested by these specimens, the toxicity of the compounds to various species, or the quantities stored under varying conditions of exposure. Direct comparisons of quantities of residues in tissues of these field specimens with those of laboratory animals are possible only in the case of bobwhite quail. Specimens found dead in Georgia (3 birds), Texas (2 birds), and in two widely separated areas in Alabama (6 birds) contained 6.3, 5.0, 7.0 and 10.9 p.p.m. of heptachlor epoxide. Since death of these birds occurred within 10 to 14 days after treatment of the areas, the tissue concentrations were comparable to those in

TABLE 3. INSECTICIDAL RESIDUES IN TISSUE OF SPECIMENS FROM AREAS TREATED WITH TWO POUNDS OF HEPTACHLOR OR DIELDRIN PER ACRE
(Figures in parentheses indicate number of specimens examined)

Species[1]	Tissue Analyzed	Found Dead Within 3 Weeks After Treatment: Dieldrin	Found Dead Within 3 Weeks After Treatment: Heptachlor Epoxide	Shot 6-12 Months After Treatment: Heptachlor Epoxide
		p.p.m.	p.p.m.	p.p.m.
BIRDS				
Water Pipit	Entire Carcass	......	38.0 (1)	8.0 (6)
Swamp Sparrow	" "	......	33.9 (2)	......
Mockingbird	" "	13.8 (2)	27.4 (4)	......
Savannah Sparrow	" "	......	26.2 (6)	2.1 (18)
Field Sparrow	" "	......	24.6 (5)	......
Orchard Oriole	" "	......	23.7 (1)	......
Chipping Sparrow	" "	10.0 (1)	22.3 (8)	......
Myrtle Warbler	" "	......	20.2 (3)	......
W.-throated Sparrow	" "	10.5 (2)	20.0 (13)	Trace (1)
Brown Thrasher	" "	6.5 (4)	16.6 (11)	22.3 (3)
Red-bellied Woodpecker	" "	14.5 (1)	14.9 (1)	......
Red-headed Woodpecker	" "	5.7 (1)	......	......
Yellowthroat	" "	......	17.5 (1)	......
Yellow-br. Chat	" "	......	14.1 (1)	......
Western Meadowlark	" "	......	13.4 (1)	......
Blue Jay	" "	3.5 (1)	12.8 (3)	......
Hermit Thrush	" "	12.2 (1)	12.6 (3)	......
Redwing Blackbird	" "	......	12.2 (3)	......
Robin	" "	......	12.1 (4)	0 (1)
Vesper Sparrow	" "	10.0 (1)	11.9 (8)	0 (1)
Common Grackle	" "	......	10.9 (6)	......
Eastern Kingbird	" "	......	10.9 (1)	......
Eastern Meadowlark	" "	6.9 (6)	10.7 (16)	0.7 (6)
Cardinal	" "	8.1 (3)	10.3 (18)	......
Bobwhite	" "	6.5 (6)	7.6 (12)	......
	Eggs	......	......	1.1 (2)
Starling	Entire Carcass	......	7.4 (1)	......
Virginia Rail	" "	......	7.1 (1)	......
Carolina Wren	" "	......	6.0 (1)	......
Mourning Dove	" "	......	5.8 (1)	1.0 (4)
Y.-shafted Flicker	" "	......	3.9 (2)	......
Eastern Bluebird	" "	......	3.2 (2)	......
Slate-colored Junco	" "	15.9 (1)	......	......
Rufous-sided Towhee	" "	7.3 (1)	......	......
Lesser Scaup	Heart	11.7 (1)	......	......
	Liver	16.0 (1)	......	......
Chinese Goose	Liver	......	1.1 (3)	1.1 (2)
	Brain	......	52.3 (3)	0 (2)
Muscovy Duck	Heart	21.5 (2)	......	......
	Liver	21.8 (2)	......	......

MAMMALS				
Cotton Rat	Entire Carcass	......	5.9 (5)	......
Oldfield Mouse	" "	......	33.5 (1)	......
Swamp Rabbit	" "	......	3.3 (1)	Trace (1)
White-footed Mouse	" "	71.6 (1)	......	......
Cottontail Rabbit	" "	1.8 (2)	......	......
	Heart	......	4.2 (4)	0 (3)
	Liver	33.4 (1)	8.1 (6)	1.0 (3)
	Kidney	63.7 (1)	6.1 (4)	3.0 (3)
	Brain	......	8.7 (2)	......
Raccoon	Heart	......	8.1 (2)	9.7 (6)
	Liver	......	3.2 (2)	3.5 (6)
	Kidney	......	10.0 (2)	5.2 (6)
	Brain	......	......	0 (2)
Armadillo	Heart	......	Trace (1)	......
	Liver	......	7.7 (1)	......
	Kidney	......	2.2 (1)	......
	Brain	......	Trace (1)	......
Red Fox (Cub)	Heart	......	5.7 (2)	......
	Liver	......	13.1 (2)	......
	Kidney	......	16.1 (2)	......
	Brain	......	1.4 (2)	......
REPTILES				
Plain-bellied Water Snake	Entire Carcass	......	11.3 (4)	......
DeKay's Snake	" "	77.5 (1)	......	......
Hog-nosed Snake	" "	......	4.2 (1)	......
AMPHIBIANS				
Green Frog	" "	23.2 (2)	0 (4)	......
Leopard Frog	" "	11.1 (9)	20.9 (1)	......
Bull Frog	" "	3.6 (2)	......	......
Salamander	" "	9.8 (3)	......	......
Toad	" "	......	3.1 (1)	......
FISH				
Black Bullhead	" "	......	17.5 (1)	......
Sunfish	" "	4.9 (1)	17.8 (4)	......
Bluegill	" "	......	36.2 (2)	......
Sucker	" "	......	0.4 (1)	......
S. E. Creek Chubs	" "	1.7 (1)	......	......
American Eel	" "	12.2 (1)	......	......
Gizzard Shad	" "	......	0.4 (1)	......
CHAETOPODS (Earthworms)	" "	......	......	3.0 (32)*
CRUSTACEANS (Crayfish)	" "	......	......	1.6 (4)*

[1]Names in this table are those used by submitters.
*Each sample consisted of an undetermined number of individuals.

laboratory specimens after similar periods of exposure.

In several instances, it was possible to compare tissue concentrations of residues in specimens from widely separated areas. Six white-throated sparrows from Texas contained 25.1 p.p.m. of heptachlor epoxide, whereas three birds from treated areas in Alabama contained 20.1 p.p.m. Savannah sparrows from three areas contained 25.1 (1 bird), 29.6 (5 birds), and 38.7 (2 birds) p.p.m. of this epoxide. Eastern meadowlarks from these same areas contained 10.8 (3 birds), 11.7 (6 birds), and 8.2 (2 birds) p.p.m. Three mockingbirds found dead in Alabama contained 22.3 p.p.m. of the epoxide; two found dead in Louisiana contained 32.1 p.p.m.

Continuing studies were conducted on some of the treated areas in efforts to obtain data on quantities of toxicant stored by different species under varying degrees of sublethal exposure. Earthworms constitute important food items for some birds, and samples taken as much as 12 months after treatment contained from 1 to 10 p.p.m. of heptachlor epoxide. Possible results of feeding upon these organisms were shown in quantities of heptachlor epoxides in tissues of woodcock on winter range in Louisiana. Only 10 per cent of birds collected shortly after arrival in the vicinity of treated land contained detectable traces of the epoxide, but more than 50 per cent of birds collected six weeks later contained an average of 0.2 p.p.m. Raccoons shot six months after land treatment contained large concentrations of epoxide in various organs, while quantities in tissues of birds ranged from traces to levels comparable to those in specimens found dead immediately after treatment. Brown thrashers shot 10 months after application of heptachlor contained 22.3 p.p.m. of heptachlor epoxide, whereas birds found dead immediately after treatment contained 16.6 p.p.m. However, the birds which were found dead also contained an average of 2.1 p.p.m. of heptachlor, whereas no free heptachlor was found in the birds which were shot later.

SUMMARY AND CONCLUSIONS

Tests upon penned animals indicated that quantities of DDT, chlordan and heptachlor residues in tissues were roughly proportional to the degree of exposure to these compounds, and that the presence of more than 20 to 30 p.p.m. of DDT, 20 p.p.m. of chlordan, or 6 to 20 p.p.m. of heptachlor epoxide in quail tissues constituted presumptive evidence that the birds ingested the equivalents of lethal dosages of these compounds. Tests with starlings, rats, pheasants and ducks indicated that these species differ in sensitivity to these compounds, and also may differ in their capacity to store residues in tissues.

Analysis of animals from areas which had been treated with heptachlor or dieldrin showed the presence of insecticidal residues in more than 98 per cent of specimens found dead shortly after treatments were applied. Concentrations of heptachlor epoxide in tissues of quail were comparable to those found in laboratory specimens known to have died as the result of heptachlor poisoning. Birds and animals shot on these areas six or more months after treatment also contained insecticidal residues.

LITERATURE CITED

Association of Official Agricultural Chemists
1950. Official methods of analysis, 910 p.
Baker, M. F.
1958. Observations of effects of an application of heptachlor or dieldrin on wildlife. Proc. 12th Ann. Conference S. E. Assn. Game & Fish Comm.: 244-247.

Barker, R. J.
1958. Notes on some ecological effects of DDT sprayed on elms. J. Wildl. Mgt., 22(3): 269-274.
Gannon, N., and J. H. Bigger
1958. The conversion of aldrin and heptachlor to their epoxides in soil. J. Econ. Ent., 51(1):1-2.
Glasgow, L. L.
1958. Studies on the effect of the imported fire ant control program on wildilfe in Louisiana. Proc. 12th Ann. Conf. S. E. Assn. Game & Fish Comm.: 250-255.
Harrington, R. W., Jr., and W. L. Bidlingmayer
1958. Effects of dieldrin on fishes and invertebrates of a salt marsh. J. Wildl. Mgt., 22(1):76-82.
Hunt, E. G., and A. I. Bischoff
1960. Inimical effects on wildlife of periodic DDD applications to Clear Lake. Calif. Fish & Game, 46(1):91-106.
Kerswill, C. J., and P. F. Elson
1955. Preliminary observations on effects of 1954 DDT spraying on Miramichi salmon stocks. Fisheries Res. Board Can. Atlantic Progress Rep., 62:17-23.
Lay, D. W.
1958. Fire ant eradication and wildlife. Proc. 12th Ann. Conf. S. E. Assn. Game & Fish Comm.: 248-250.
Mitchell, R. T., H. P. Blagbrough, and R. C. Van Etten
1953. The effects of DDT upon the survival and growth of nestling songbirds. J. Wildl. Mgt., 17(1):45-54.
Newsom, J. D.
1958. A preliminary progress report of fire ant eradication program, Concordia Parish, Louisiana—June, 1958. Proc. 12th Ann. Conf. S. E. Assn. Game & Fish Comm.: 255-257.
O'Donnell, A. E., H. W. Johnson, Jr., and F. T. Weiss
1955. Chemical detemination of dieldrin in crop materials. J. Agr. & Food Chem., 3(9): 757-762.
Ordas, E. P., V. C. Smith, and C. F. Myer
1956. Spectrophotometric determination of heptachlor and technical chlordan on food and forage crops. J. Agr. & Food Chem., 4(5):444-451.
Scott, T. G., Y. L. Willis, and J. A. Ellis
1959. Some effects of a field application of dieldrin on wildlife. J. Wildl. Mgt., 23(4): 409-427.

DISCUSSION

DISCUSSION LEADER DUSTMAN: Dr. DeWitt has come up with some findings that heretofore have not been adequately presented, and he has done a fine piece of work in this age of amino triazol, diethyl stilbestrol and heptachlor and so on endangering wildlife and humans. I think we should be fully cognizant of the dangers associated with these chemicals.

MR. LIVINGSTON [Toronto, Canada]: As I understand it, there is a zero tolerance for heptachlor in foodstuffs. What I wonder is what the possibility might be of a hunter, say, eating the pheasant or quail which had heptachlor in its system.

DR. DEWITT: It is correct that at present all foodstuffs have a tolerance of zero for both heptachlor and heptachlor epoxide. The evidence which we have found considering the birds which died on treated areas and those that were shot there many months later, show there is a high probability that the resident population will contain variable quantities of the heptachlor epoxide.

MR. VERNON STEVENS [Columbus, Ohio]: A student working on the problem using the chemical endrin, at Ohio State University has found similar effects on the various organs in the blunt-nosed minnow. You mentioned the relative amounts in the heart, liver, kidney and so forth. He found the concentration of endrin in these organs with also relative degrees in the blunt-nosed minnow.

MR. PHIL AGEE [Lincoln, Nebr.]: Was any attempt made in the study to relate sublethal doses with some other physiological effects on the birds such as the rate of reproduction?

DR. DEWITT: We did make such observations. In general, we found that when quail and pheasant are exposed to sublethal dosages of any chlorinated hydrocarbons either prior or during the breeding season reproduction is at least partially inhibited, that there may be a reduction in fertility and hatchability of eggs, and in general a sharp reduction in the viability of the chicks.

TECHNICAL SESSIONS

Tuesday Morning—March 8

Chairman: JAMES W. BROOKS[1]
Chief, Division of Game, Alaska Department of Fish and Game, Juneau, Alaska

Discussion Leader: GEORGE A. BARTHOLOMEW
Department of Zoology, University of California, Los Angeles, California

---

COASTAL AND MARINE RESOURCES

METHODS OF ENUMERATING SALMON IN ALASKA

RICHARD R. STRATY
U. S. Fish and Wildlife Service, Bureau of Commercial Fisheries, Juneau, Alaska

The purpose of this paper is to discuss the various methods currently used or being developed by the Bureau of Commercial Fisheries in Alaska for enumerating adult and juvenile salmon.

Successful management of Alaska's salmon resources is dependent upon accurate prediction and subsequent assessment of the size of salmon runs returning to spawn. Predicting the magnitude of returning runs and manipulating the catch and escapement require a continuous inventory of salmon during various stages of their life history.

Five species of Pacific salmon are fished commercially in Alaska: king, *Oncorhynchus tshawytscha;* red, *O. nerka;* pink, *O. gorbuscha;* coho, *O. kisutch;* and chum, *O. keta.* Most of the research effort directed toward perfecting methods of enumeration, however, has centered on the two most commercially important species, red and pink salmon.

[1]In the absence of the chairman, Discussion Leader Bartholomew presided.

ADULT ENUMERATION

The size of a returning salmon run is usually determined by adding the commercial catch to the escapement. The relationship between escapement and return has formed the principal basis for predicting returning runs. In certain areas of Alaska, estimates of the daily escapement play a critical role in management of the fishery. In the Bristol Bay region, the largest producer of red salmon in the world, and on Kodiak Island, daily counts are made of salmon as they ascend the main rivers to the lakes.

Weirs and Towers

Until recently weirs constructed across several of the trunk streams that lead to the spawning grounds provided the only means of obtaining the day-to-day escapement estimates necessary for management of the Bristol Bay fisheries. Because of the expense and time required in construction and maintenance of weirs, the number of rivers that could be covered in this way was limited. Estimates of the escapements on unweired rivers were based on aerial surveys of the spawning grounds, carried out in accordance with methods described by Kelez (1947) and Eicher (1953).

Red salmon, in ascending the main trunk streams, characteristically migrate next to the banks within a few feet of shore (Figure 1). Early workers in Bristol Bay made use of this characteristic by making visual counts of salmon at irregular intervals from high banks, particularly on the Egegik River. Their assessment of the runs, however, was qualitative rather than quantitative, indicating only that the runs were larger or smaller than those of prior years. Weirs, whenever and wherever used, provided the only reliable means of obtaining a quantitative measure of the escapements until the early 1950's.

In 1953, the Fisheries Research Institute of the University of Washington erected portable towers on the banks of the Wood River. The towers afforded ready observation of the migration paths of adult salmon, and sample counts were made at regular intervals throughout the season; thus, a quantitative estimate of the Wood River escapement was possible for the first time since 1919 when the weir was removed.

To test the reliability of the tower method of enumeration, the Bureau made comparisons between tower and weir estimates on the Egegik River in 1956 and the Naknek River in 1957. In both years, towers located 1 to 2 miles above the weirs provided estimates of the escapements that agreed closely with the estimates gained by operation of the weirs.

Figure 1. Migrating red salmon, Egegik River, 1956 (view from tower).

For the period July 12-30, 1956, when comparable tower and weir counts were attempted on the Egegik River, weir operators estimated the escapement at 1,064,000 red salmon. An estimate based on the upstream tower counts indicated the escapement for this period was 985,000, 7.4 percent lower than the weir estimate. Much of the difference occurred on July 16 and 17, when tower estimates were lower than weir estimates by 15,000 and 73,000 respectively. On these days fish passed through the left side of the weir for the first time during the season, and it was not until noon of the second day that a tower could be erected on the left bank to obtain counts of fish moving up this side of the river. Omitting the two days, the total estimate from tower counts was only 1.6 percent lower than the weir estimate.

During the period from June 29 to July 31, 1957, comparable weir and tower counts were obtained on the Naknek River. Weir operators estimated an escapement of approximately 631,000 red salmon, while tower operators estimated an escapement of approximately 712,000, 12.8 percent more than the weir estimate. Most of the difference between tower and weir counts occurred on July 8 and 9, during the peak of the run, when the tower estimates were 51,000 and 25,000 higher than weir estimates. Much of this error was attributed to the development of leaks in the weir during this period. This was borne out by the fact that tower personnel observed large numbers of fish in the early morning, several hours before the weir gates were opened. If the counts for the two days are omitted from the comparison, the estimated total based on tower counts was only 0.9 percent higher than that obtained at the weir.

Tower estimates of the Egegik and Naknek River escapements in 1956 and 1957 were considered to be sufficiently accurate to warrant discontinuing the costly weir program in Bristol Bay. Removal of weirs, however, posed new problems, not the least of which was that of gauging the extent of night migration. The fishing season is short in Bristol Bay and, during its height, periods of darkness vary in length from 3 to 6 hours, depending upon atmospheric conditions.

In the normal operation of weirs, the counting gates are closed at night and enumeration is discontinued until morning. The shift to observation towers necessitated developing satisfactory lighting arrangements which would not unduly disturb the normal nocturnal migration of salmon and which would permit a suitable assessment of their numbers.

Extensive lighting experiments were conducted on Bristol Bay rivers in 1958. Several methods employing sealed beam flood and spot lights of 300 to 600 watts were tried both above and below the water surface. The arrangement that proved most satisfactory was one in which the light source was located on shore not more than 5 feet above the surface of the water, with the beam of light directed downstream at an angle of 45° to the bank. The light was set so the beam hit the water surface about 10 feet from shore. This resulted in a darkened area next to the river bank. Migrating fish entering the illuminated area tended to lead toward shore along the downstream edge of the beam and pass through the darkened area, where there was enough diffused light to permit visual counts.

Measures to improve visibility during daylight hours included: (1) use of Polaroid glasses; (2) placement of light-colored 4-by 8-foot hardware cloth panels on the river bottom across the migration path; and (3) anchoring of floating, fence-like structures upstream from the towers to dampen surface turbulence over the counting areas.

The techniques used in enumerating salmon from towers, while not perfect, have reached a routine operational stage. At present each tower station is manned by three people, with one observer on duty at all times during the season. Counts are made for 10 minutes out of each hour on both the left and right banks of the river. Estimates of the total number of fish in the escapement are obtained by simple expansion of the sample counts. Preliminary analysis indicates that

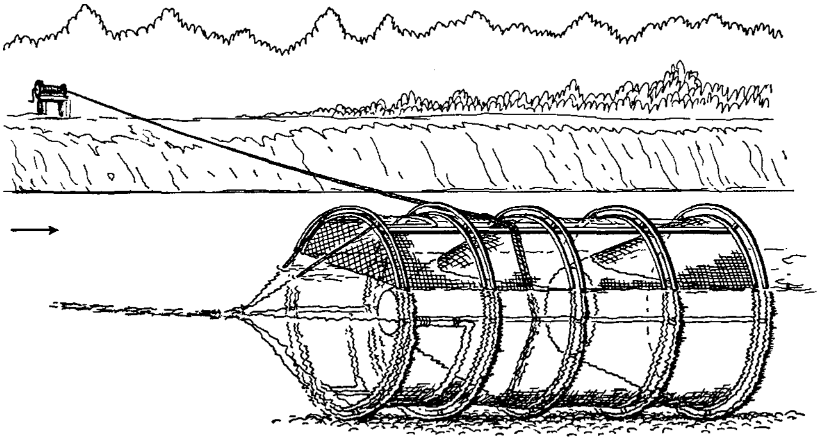

Figure 2. Wire fyke trap used on the Kenai River.

10-minute sample counts will yield estimates of the escapement within 3 to 5 percent of that which might be obtained by a total count.

Fyke Trapping

Many rivers in Alaska are of glacial origin and extremely turbid, precluding the use of visual counts. This is particularly true in the important red salmon producing area of Cook Inlet. Here, studies were conducted on the Kenai River from 1957 to 1959 to develop a method of obtaining indices and estimates of the daily escapement through test-fishing.

The gear used was cylindrical wire fyke traps that were 10 feet in diameter and 18 feet in length (Figure 2). They were similar to those developed by the California Department of Fish and Game (Hallock, Fry, and LaFaunce, 1957) for use on the Sacramento River to estimate adult salmon and steelhead trout runs. Traps of this type were also used by the Oregon Fish Commission on the Snake River in Oregon to estimate king salmon and steelhead trout runs.

Two index traps were fished in the same location each year, one on each side of the river. A one-quarter-inch wire rope, securely attached at one end to a longitudinal stringer of the trap, was wrapped around the trap several times. The other end of the rope was attached to a hand winch. Operation of the winch retrieved the trap from the river by rolling it shoreward and upward on the bank. Launching the trap consisted of simply pushing it into the river. Once started, it rolled into position through its own momentum.

Traps were emptied twice daily, the salmon were counted and tagged, and certain biological information was obtained. Results of these studies indicated that fyke traps were effective in capturing fish in proportion to their numbers in the swift, turbid waters of the Kenai River. There was close agreement between daily catches in each trap. There was also close agreement between the commercial catch of red salmon and the fyke trap catches, both in timing of the run and characteristics of the curve of abundance. Since traps did not appear to fish selectively for red salmon of a particular size range, sample catches could be used to assess certain characteristics of the escapement, for instance, age-group structure, sex ratio, and size of individual fish.

Estimates of the total number of red salmon in the escapements to the Kenai River, based on tagged to untagged fish ratios, proved of little value chiefly because of difficulty in establishing a satisfactory method of tag recovery.

Visual Aerial and Surface Surveys

In the important pink salmon producing areas of Southeastern Alaska, Prince William Sound, and the Alaska Peninsula, the large number of streams precludes the use of towers or weirs, except in a few cases in support of biological studies. Frequent aerial surveys of the spawning grounds during the fishing season afford the quickest and most economical means of obtaining an immediate estimate of the numbers of fish which have escaped the fishery.

The techniques currently employed follow closely those developed by Kelez (1947) for use in Bristol Bay and are described in some detail by Eicher (1953). Best results are obtained with aircraft having a long range and providing good visibility downward on either side, and which can be safely flown at speeds of 100 miles per hour or less at altitudes varying from 500 to 800 feet.

Essentially the method employs a two-man team—a pilot and a trained or experienced observer. During a survey run on a stream or beach spawning area, the pilot keeps the observer in continual visual contact with the fish and maintains the correct altitude while the observer makes his count or estimate.

On sparsely populated streams the fish are counted individually. However, on the majority of streams the observer counts in groups or blocks of 10, 100, or 1,000 fish.

The usual procedure followed when an estimate of the total escapement to a particular spawning area is desired, is to visit that area several times during the season. This assures that observations will be made during the peak of spawning when the bulk of the escapement can be most easily counted. It is characterized by widespread spawning and few schooled or dead fish.

On small streams surface or foot surveys provide a more accurate means of censusing salmon, but the excessive cost of this method limits its use. Occasionally surface surveys are used in place of aerial survey on important streams that cannot be adequately covered by aircraft. These are usually streams that are hidden from the aerial observer's view by overhanging trees and brush.

Usually a two-man team is used when covering a stream on foot. Methods of counting vary with the concentrations of fish. In most instances the fish are counted individually on a hand tally by each member of the party. After completing a survey of a stream or section of a stream, the counts by each man are totaled and the average is taken as the count for the area.

JUVENILE ENUMERATION

Predictions based on the relationship of adult returns to parent spawners have, at times, proved discouraging, primarily because of widely varying survival rates. A more reliable basis for prediction would be gained if the numbers of juvenile salmon that migrate to sea were known. Information of this nature is necessary to determine the survival rates from egg to migrant stage.

Red Salmon Smolt Enumeration

Investigations have been under way on several rivers in Bristol Bay since 1956 to develop a reliable and economical method of assessing the annual seaward migration of red salmon. Preliminary studies were designed to learn the daily and seasonal timing of the outmigration, how the smolts were distributed in relation to water depth, velocity, and cross-section of stream, and their ages and relative size. Knowledge of these features was considered essential to the development of adequate sampling equipment and techniques.

Efforts have been directed toward randomly sampling on a 24-hour basis an entire cross section of the Naknek, Egegik, and Ugashik Rivers, using fyke nets to capture smolts (Figure 3). Fyke nets of this design had been used by the Fisheries Research Institute on the Wood and Kvichak Rivers in Bristol Bay to obtain an annual index to the red salmon outmigration.

On the Naknek River a three-eighth-inch galvanized steel cable 720 feet in length was strung across the river bed from bank to bank. The cable was divided into fifteen 48-foot increments. Each division was designated as a fishing site. Head lines of three-eighth-inch manila rope were attached to the cable to mark the 16-foot, center

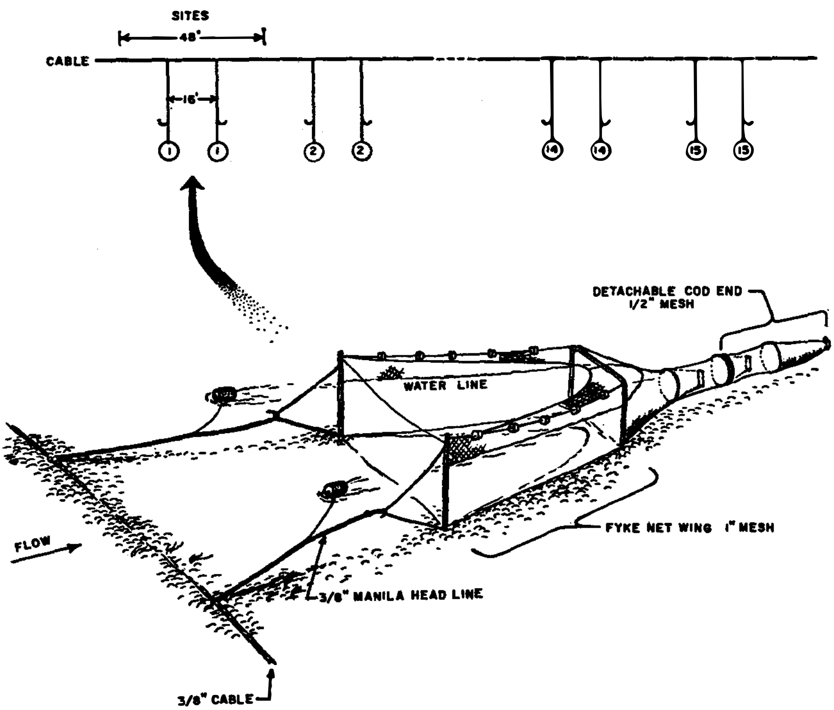

Figure 3. Fyke net set up used to enumerate red salmon smolts.

section of each site (Figure 3). The trailing end of each head line was buoyed to the surface with a spongex float bearing the number of the site. A fyke net could be quickly attached to any pair of head lines delineating a specific fishing site. Fyke nets were fished with an 8-foot opening, thus fishing only one-half of the center 16-foot section or one-sixth of the total area of the fishing site.

The sampling schedule was of Latin square design randomized with respect to sites, time periods within days, and days of season. All 15 sites are fished in random order each day for a specified period of time. Estimates of the total number of smolts are derived as follows:

$$X = \frac{W}{F} PD \bar{x} \quad \text{where}$$

W = width of river at trapping station
F = width of fyke net opening
P = number of fishing periods within day
D = number of days in trapping season
$\bar{x}$ = average catch per standard fishing period

It should be emphasized that estimates based on fyke net catches probably are low because fish avoided the nets. The degree to which smolts may evade capture in various velocities remains to be evaluated. Casual observations led to several general impressions: (1) In the lower velocities encountered at points away from the main channels, smolts can and do swim out and around the wings of the nets; (2) larger fish are better able to evade capture; (3) the efficiency of fyke nets approaches 100 percent in velocities of 5.5 feet per second and higher; and (4) the ability of smolts to avoid capture might vary, also, with changing light intensity in a manner now unknown. Until these relationships can be definitely established, the estimated totals must be regarded as underestimates whose principal value is that of being amenable to statistical treatment in evaluating annual differences in smolt abundance.

Pink Salmon Fry Enumeration

Salmon research in Prince William Sound and Southeastern Alaska has included development of sampling and trapping techniques to estimate the abundance of pink salmon fry produced in streams and intertidal areas.

To sample fry abundance in streams, rectangular fyke traps (Figure 4) capable of fishing from top to bottom of the stream, are placed at regular intervals across the width of the stream. The traps are anchored in the stream by means of two pipes suspended from a wooden catwalk or driven into the stream bed. Trap arrays are usually located far enough upstream to be above the influence of tides and are fished continuously throughout the fry run.

The percentage of migrating fry caught in a set of traps is determined through mark and recovery experiments. In early trials fry were anesthetized and marked by fin-clipping. This method prohibited the marking of large numbers of fry and made visual examination of large catches for marked fish exceedingly difficult and time consuming.

In 1958 and 1959, fry were marked with neutral red stain. The most successful staining combination was a mixture of stain and water at concentration of 1:300,000 in which fry were immersed for seven hours. Fry remained stained at least 72 hours after being removed from the solution.

Staining was considered superior to fin-clipping since the fry do not have to be anesthetized and large numbers can be marked simultaneously. The redidsh-colored fry are easily distinguished from the unstained in separating marked from unmarked.

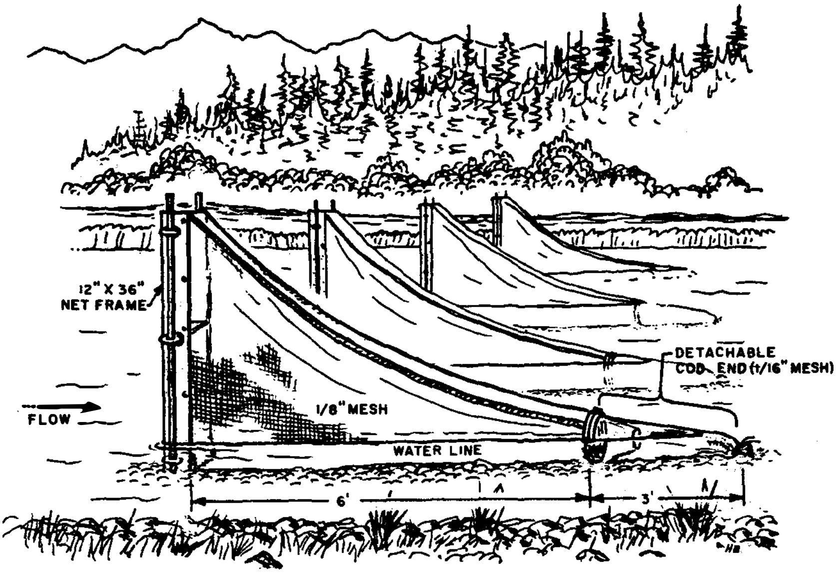

Figure 4. Array of pink salmon fyke traps.

Production in Intertidal Areas of Streams

To estimate the abundance of fry in the intertidal areas of streams, a number of square-yard quadrats are sampled at random. The average number of pink fry, larvae, and eggs per unit area is applied to the intertidal zone to arrive at an estimate of the total.

Sampling is accomplished by excavating in the quadrats with an "egg pump," which was designed by the Fisheries Research Institute. The device is powered by a gasoline engine and forces a mixture of air and water through a hard rubber hose that is inserted in the gravel. The air forced into the gravel assures floatation of any fry, larvae, or eggs present. A heavy wire-mesh frame, open at one end, is used to outline the sample quadrats. The fry, eggs, and larvae are carried by the current into the collecting net located immediately downstream from the open end of the frame.

SUMMARY AND CONCLUSIONS

The regulation of Alaska's salmon fisheries and the success of biological studies currently in progress are dependent to a great degree upon precise counts of migrating salmon at the adult, smolt, and fry stages of their life cycle.

Estimation of adult red salmon escapements from observation towers is sufficiently precise to warrant the widespread use of towers in Bristol Bay.

Large cylindrical fyke traps on the Kenai River are useful in obtaining an index to the abundance of red salmon adults in turbid Alaskan streams.

Aerial surveys are the most economical and quickest method of obtaining immediate estimates of the escapement in Southeastern Alaska and Prince William Sound.

On small streams, surface or foot surveys are more accurate than aerial surveys for estimating the size of spawning populations. Their principal use is on streams where aerial surveys are not feasible or where a greater degree of accuracy is needed.

Fyke nets are fished in Bristol Bay in accordance with a prearranged schedule to obtain an estimate of red salmon smolts.

Arrays of rectangular fyke traps are used in Southeastern Alaska and Prince William Sound streams to estimate the total number of pink salmon fry produced.

A successful method of temporarily staining fry with neutral red is superior to fin clipping in mark and recovery experiments.

Random sampling of the intertidal stream's spawning areas with an "egg pump" provides a means of estimating the fry production where trapping methods are not possible.

ACKNOWLEDGMENTS

The author wishes to acknowledge the helpful advice and assistance in preparation of this paper given by Charles DiCostanzo, Chief of Red Salmon Investigations, Bureau of Commercial Fisheries in Alaska. The author is also indebted to Jerry Hout, James Kirkwood, and Loyal Bouchard, individual project leaders of the studies described, for supplying some of the material used in this paper. Illustrations were prepared by Herb Bonnett.

LITERATURE CITED

Eicher, George J., Jr.
1953. Aerial methods of assessing red salmon populations in Western Alaska. Journal of Wildlife Management 17(4):521-527.

Hallock, Richard J., D. H. Fry, Jr., and Don A. LaFaunce
1957. The use of wire fyke traps to estimate the runs of adult salmon and steelhead in the Sacramento River. California Department of Fish and Game. 43(4):271-298.

Kelez, G. B.
1947. Measurement of spawning populations by means of aerial photography. Pacific Fisherman. 45:56-51.

DISCUSSION

MR. LOGER [Michigan]: Have you made any examination of the stomachs of stream predators to learn about the increased predation on the young?

MR. STRATY: I don't believe so, as yet. I am not familiar with what the boys have been working on. However, I have not heard of any work done in that connection.

MR. CROSS [Kansas]: I too am interested in this stain; we did this with small fish of various kinds in some warm-water streams in our state and have had good success with a stain called "Bismarck-Brown-Y," which held up for approximately two weeks.

MR. STRATY: I might say that the stain that we use was a neutral red and was used in a concentration of one part stain to 300,000 parts water in which the fry were immersed for about seven hours. They remained stained for about 72 hours after being taken out and transferred to fresh water. Of course, we tried a number of stains and we did have some mortality in connection with them. However, we are now using this neutral red.

CHAIRMAN BARTHOLOMEW: Have you ever considered the possibility of using lapse-time photography in your investigations towers so that you will not have to have three men on duty at all times?

MR. STRATY: I believe that the Fisheries Research Institute has done some work on numerating adult salmon by the use of photography. We, ourselves, have not done much with photography, although we have considered various methods of using it.

OIL POLLUTION OF THE SEAS

LESTER A. GILES, JR.
The American Humane Education Society, Boston, Massachusetts and

JOHN LIVINGSTON
Audubon Society of Canada, Toronto, Canada

Oil pollution of the sea was not a problem prior to World War I when fuel oil came into widespread use. Increased domestic use of oil at this time resulted in a vast increase in the need for transportation in ships. There has always been some natural seepage of oil into the sea from underwater and shoreline deposits of oil. This, together with the resulting oil slicks caused by numerous sinkings of ships during both World Wars, has caused an extensive and serious pollution problem. In addition, there has been a considerable and continuous amount of oil dumped by ships. Birds did not become radically involved until the 1930's.

In the last decade or two the problem has become more and more acute. There has been a great increase in the amount of oil being transported all over the world; oil wastes are increasing in rivers and harbors; oil from sunken ships continues to make its appearance; expanded shipping traffic has resulted in an increase in dumping.

North America is not alone in this problem. The United Kingdom and western Europe have had beaches contaminated over and over again in the past several years. The accompanying loss of bird life has been almost beyond belief. Both coasts of our continent are involved in this problem to varying degrees. According to Leslie M.

Tuck of the Canadian Wildlife Service, the bulk of the damage in eastern Canada occurs off the coast of Newfoundland. On the east coast of the United States, John Dennis states, the most polluted section at the present time is that portion between Boston and New York. This does not mean that the rest of the East Coast is free of pollution. Florida beaches have had a considerable amount of contamination in recent years. Less is known about conditions on the west coast of the United States and Canada. To our knowledge there is also serious contamination in the North Atlantic, the North and Baltic Seas.

In 1924 a conference on oil pollution was called in Washington, to which most of the major maritime nations sent representatives. Discussion led to the drafting of an International Convention which if ratified by the attending nations could have become international law. For some reason no one signed it. In 1954 another meeting was held in London. The problem had, in the meantime, become much more severe. The result of this conference was a document called the 1954 Convention Relating to Pollution of the Seas by Oil. Among other things, this established zones of sea in which oil dumping was to be abstained from by all participating countries. It was subsequently signed by the required ten nations. The United States did not sign this Convention due to certain clauses which did not seem commensurate with United States law.

This does not mean to say that local and federal laws in the United States were poor or lacking; they were and are among the best. It does not mean that the United States did not have port facilities for handling the cleanings from bunkers and bilges. It does mean, however, that the United States has been deprived of effective means of preventing oil dumping outside its territorial twelve miles by ships of either its own or of foreign registration.

In 1959 a further conference was called in Copenhagen, Denmark. The sponsoring organization was the British Section of the International Council for Bird Preservation, and some countries sent official observers. The authors were present. The United States State Department sent Mr. John W. Mann, Executive Secretary of the National Oil Pollution Committee, as its official observer. It was Giles' good fortune to read a statement to the Conference that the United States Committee had reversed its previous stand regarding the 1954 Convention and would recommend that the United States Senate ratify that Convention with two or three technical exceptions. These related to commitments regarding the provision of harbor reception facilities. Other points, it felt, could be worked out through participation in the International Maritime Consultative Organization (a UN agency). There the situation rests at the date of writing—an international problem requiring an international solution.

Our prime interest in oil pollution of the sea centers around wildlife. Many forms of life may be involved in North America, but the most conspicuous to date have been seabirds. In other parts of the world, such as Britain, recreational interests, public health factors, harbor ameneties and others are involved as well.

The focal point of the problem on our East Coast is in Newfoundland. By far the bulk of the damage to seabirds occurs in the waters adjacent to that island, where the annual kill is quite literally enormous. Pending more extensive data, pollution in this area is thought to originate from ships using the heavily-traveled North Atlantic routes. It results from the cleaning of tanks, flushing of bunkers, disposal of "burnt" lubricating oil, etc., while under way. This is done to save turn-around time; to eliminate non-productive time in port. A very few gallons of persistent oily waste can destroy many thousands of seabirds.

A relatively small quantity of oil can spread out to cover a very large area. The British have demonstrated that 15 tons of oil (a nominal amount) dropped into a calm sea have covered eight square miles in less than a week. And oil is a remarkable traveler. Individual slicks have been traced for hundreds of miles. Local peculiarities of current, wind or tide can thus contribute to the damage where there are heavy concentrations of birds.

Virtually all species of North Atlantic seabirds are affected by oil. Most noteworthy in the Newfoundland area are murres, eiders, and razor-billed auks. Eiders, concentrated in bays and estuaries during the winter, are most hard hit by oil dumped near shore or brought into shore by winds and currents. Murres are affected inshore and offshore. In terms of numbers, murres suffer the heaviest toll, although razor-billed auks are so scarce in Newfoundland today that it is doubtful they could stand any further pressure.

Once contaminated by oil, a bird has very little chance of recovery. Oil "glues" the outer feathers together, exposes and mats the down underneath. Natural insulation destroyed, the bird has no further protection from water temperature. It dies from exposure. According to Tuck, a spot of oil no larger than a quarter dollar will kill a murre, if it is on the vulnerable underparts.

When a diving bird surfaces in an oil slick, its back and wings are fouled. It usually dies from starvation. Some of these immobilized birds are washed inshore alive where they attempt to preen. In the process, some oil may be fatally ingested. Beached birds along the Newfoundland shore are often picked up by foxes.

Estimates of total kill are very difficult to come by. First there is the problem of making actual counts. A further complication lies in the fact that many oiled birds die and disappear at sea before they can be counted. Those which do reach shore are said to represent only a fractional per cent of the total number killed annually.

In February, 1960, Harold Horwood, Secretary of the Natural History Society of Newfoundland, described the 1959-60 kill in that area as "the worst in history." The razor-billed auk has been so reduced in Newfoundland that it is now considered almost extinct as a local population, though it nested in many thousands on Newfoundland island twenty years ago. The total kill of murres and others during the current winter in that area is expected to run into the hundreds of thousands.

The birds of Newfoundland are particularly vulnerable to oil pollution due to an unhappy combination of factors: ocean currents, shipping lanes, and the location of their winter food supply. Thick-billed murres from the Canadian Arctic winter in vast numbers from the Newfoundland shore to the edge of the continental shelf in an area approximately 300 miles square. Pressure of pack ice carried south on the Labrador Current often further compresses the murre concentrations along its southern edge south and east of the Avalon Peninsula. This area unfortunately coincides with the established route traveled by major shipping traffic bound to and from east coast North American ports of call. Local currents often compound the problem by carrying slicks close inshore.

At the 1959 Copenhagen Conference, it was resolved that nations bound by the 1954 Convention, together with IMCO, should as a matter of urgency examine the need for extending prohibited zones in such areas as the Gulf of St. Lawrence, the Grand Banks of Newfoundland and other parts of the eastern seaboard. It is to be hoped that future investigations will indicate the precise zoning to be adopted, encompassing a sufficiently large area to protect wintering seabird populations (Figure 1).

It must be remembered that at this date the United States is not a member of the 1954 Convention. Present member nations representing perhaps no more than 50% of the world's shipping feel that ratification by the United States would provide a strong incentive to all other uncommitted shipping countries. Of particular concern in this connection are the "flags of convenience" who are not yet members.

Even when the United States does ratify, the problem will not be solved. The ultimate goal must be total prohibition—and actual avoidance—of the dumping of persistent oils anywhere at sea. The

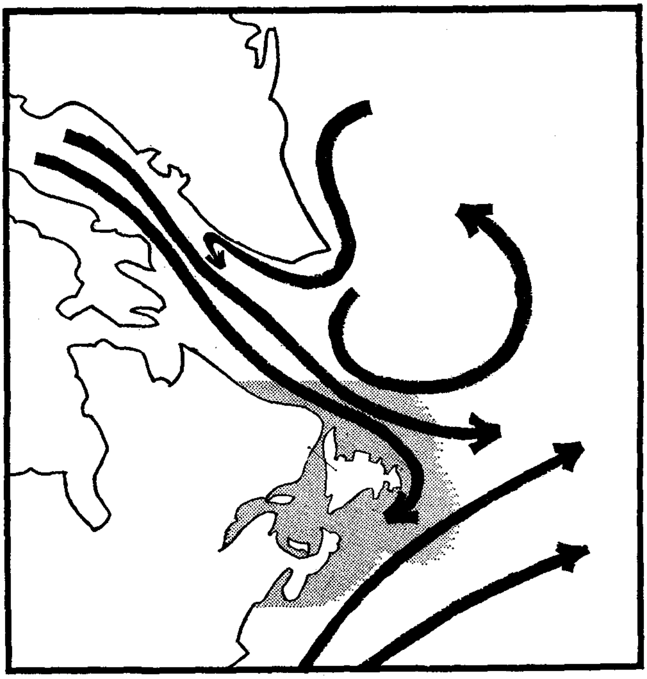

Figure 1. Shaded area represents recommended zones in which oil dumping would be completely prohibited. Arrows indicate major ocean currents.

authors do not believe there are any so-called "safe" areas of ocean, although dumping areas still exist in the North Sea, the Baltic, and most of the Atlantic, and in other parts of the world.

In the interim, more effective methods of dispersing oil already dumped must be devised. To make total avoidance feasible, there must be improved reception facilities both from quantitative and qualitative standpoints at ports of call. Separators must be built into all new ships. Enforcement must become an international reality.

Efforts in this ultimate direction can only be successful when North American conservationists have a well-documented case concerning the effects of oil, its precise origins, its persistence, and its drift, along all our coastlines. Present knowledge of the effects of oil pollution in North America — meager as it is — is limited almost exclusively to birds. Much more is needed on this subject alone, but there are indications that research should be extended to include shellfish and other marine invertebrates, and such ecological disruptions that investigation is almost certain to reveal.

In referring to improved international cooperation and enforcement, we do not imply any need to convince other countries of the necessity. Many of them know the necessity better than do we in Canada and the United States. We are referring to easier means of cooperation, such as the meeting held in Copenhagen in 1959. There should be regularly such conferences (which provide the basis for improved international action) until the problem has been resolved.

We must also bend every effort to bring these matters before the eyes of the general public, so that future action by way of legislation is understood and supported, and private efforts to alleviate the effects of pollution are appreciated. Finally we ask that any individual or organization in a position to and willing to make a contribution of finances, public education or research join with us to the end that effective action will reduce the tremendous loss of life and economic damage that so far has been increasing year after year.

In Canada, interested parties should contact Audubon Society of Canada, 423 Sherbourne Street, Toronto 5. In the United States, contact Oil Pollution Survey, The American Humane Education Society, 180 Longwood Avenue, Boston 15, Massachusetts.

LITERATURE CITED

Anonymous
1958. Annual report for 1958, The International Committee for Bird Preservation, pages 20-30.
1953. Oil pollution of the sea, Report of proceedings, International Conference, London, October 1953. Co-ordinating advisory committee on oil pollution of the sea.
1959. Proceedings of the Merchant Marine Council, U. S. Coast Guard. Vol. 16, No. 10, October 1959, pages 199-203.
1956. Pollution of the sea by oil, United Nations ST/EAC/41, New York, 1956.

Barclay-Smith, Phyllis
1956. Oil pollution of the sea, paper presented at XV Assemblée plénière de la Commission International pour l'Exploration de la Mer Mediterranée, Istanbul, September 1956.

Dennis, John V.
1959. Oil polution survey of the United States Atlantic Coast, American Petroleum Institute.
1960. Oil pollution survey of the Great Lakes, American Petroleum Institute.

Horwood, Harold
1959. Death has a rainbow hue, Canadian Audubon, May-June 1959, pages 69-73.

Tuck, Leslie M.
1959. Oil pollution in Newfoundland, International Conference on Oil Pollution of the Sea, Copenhagen, 3 and 4 July.

DISCUSSION

DR. LEWIS [Nova Scotia]: I think I ought to add to the record pollution of the sea by oil in winter on the coasts of western Nova Scotia.

MR. KELLY [New Jersey]: There should also be added to the record the amount of oil pollution that goes into the waters around New York Harbor from oil refineries and storage areas. The estuaries and other smaller streams in the area have been destroyed by oil so completely that all forms of wildlife have ceased to exist. It might be well to point out that as well as the many tankers who are blamed for this pollution and who are undoubtedly guilty, the companies in whose areas they unload are equally guilty of polluting the streams.

MR. MUNRO [Ottawa]: This is an excellent paper and I want to commend the authors for its preparation and presentation.

The point might be brought out that the profit motive underlies to a great extent the problem of oil pollution and that it is easy for the shipping operator to dispose of oil wastes in such a way that they need only to dump it at sea. This is a highly technical matter with which I am particularly well acquainted. I think that practices should be developed which will reduce this hazard, and possibly one way of solving this would be to have legal restrictions.

MR. GILES: Of course, time limited us in a discussion of some aspects of this. However, one of the things which we think is significant in talking with naval architects is that the new so-called super tankers are being so constructed that one or more of the bunkers within the ship are being constructed for use as oily water separator units within the ship, so that it can clean between ports when empty and going back to refill and not put the seas in a polluted state enroute.

MR. LOGER [Michigan]: What is the picture in the Great Lakes, where we face increased shipping and the prospects of concern for this type of pollution?

MR. GILES: A survey in connection with oil pollution of the Great Lakes has just been completed and since the opening of the St. Lawrence Seaway it is definitely on the increase.

MR. LOGER: Do we have protective legislation, at the present time, for inland waters?

MR. GILES: Yes, we do. The Federal law applies there, as well as the Canadian Federal law. So far our difficulty of administering the pollution laws is as follows—the Corps of Engineers of the United States is charged with the administration of Federal laws. The Coast Guard has been acting as their eyes and ears and will pick up the data necessary to successfully prosecute a case and turn it over to the Corps for prosecution. However, where the Coast Guard is not operating, nothing happens.

Yet all we, as private citizens, have to do is take an empty milk bottle, fill it with the oily residue, take a picture as the best evidence and submit it to the Corps of Engineers and the matter will then be taken care of.

MR. SELKE [Minnesota]: I wish to point out that because of the increased number of ships coming through the locks at the Soo, the condition has worsened considerably there. The Department of Conservation in Michigan will operate in coordination with the State of Wisconsin and with those in charge of water pollution and, as a result, try to take care of this situation where state laws apply. Of course, I think we should do the best we can and then augment these results with regulations by the Federal Government. I do think that locally the sportsmen and the conservationists should be very adamant about it. Their influence will do a great deal to make the Federal Government and its agencies more attentive to the problem.

PROBLEMS OF WHALE CONSERVATION

RICHARD M. LAWS
National Institute of Oceanography, Wormley, Surrey, U.K.

It is a matter of history that with unrestricted hunting, whales have been progressively depleted, species by species in area after area. As yet no species has been completely exterminated by man, but some have been reduced to very low levels and are slowly recovering under complete protection. There is evidence that the most valuable species are at present declining in spite of partial protection.

The stocks of whales are an important world resource. In recent years world whale oil production has been about 500,000 tons annually, obtained from about two million tons of raw material; the present annual value of the catch is some fifty million pounds. In addition to oil, the products include frozen meat, meat and bone meal, meat extract and other by-products. Its future importance as a source of protein could well be much greater than at present. Clearly, the maintenance of this industry on a long-term rational basis is desirable.

It is my purpose in this paper to describe what steps have been taken to conserve the stocks of whales and to discuss some of the more important problems encountered, particularly the difficulties in the way of understanding the population dynamics of whales, on a sound knowledge of which conservation measures should be based.

THE DEVELOPMENT OF MODERN WHALING

There have been three main phases in the commercial exploitation of whale stocks, each with a different emphasis. The first, Arctic whaling for right whales (Balaenidae) was most important in the seventeenth and eighteenth centuries, and was dominated by the Dutch and British. Then in the nineteenth century a world-wide industry for sperm whales reached its peak and declined. This was largely the province of American whalers.

Both right whales and sperm whales are slow moving and float when killed. They can therefore be killed with relatively primitive equipment. The rorquals (Balaenopteridae) are fast-swimming and usually sink when killed, and it was not until Svend Foyn in 1864 introduced the harpoon gun, mounted on a powered catching boat and firing an explosive harpoon, that the third great period of whaling could begin. This has been largely dominated by the Norwegians.

It was at first confined to shore whaling in North Atlantic waters, but the development of the floating factory ship and the exploitation of new whaling grounds in the Antarctic (Fig. 1) resulted in a great expansion of the industry. Modern whaling depends on the five

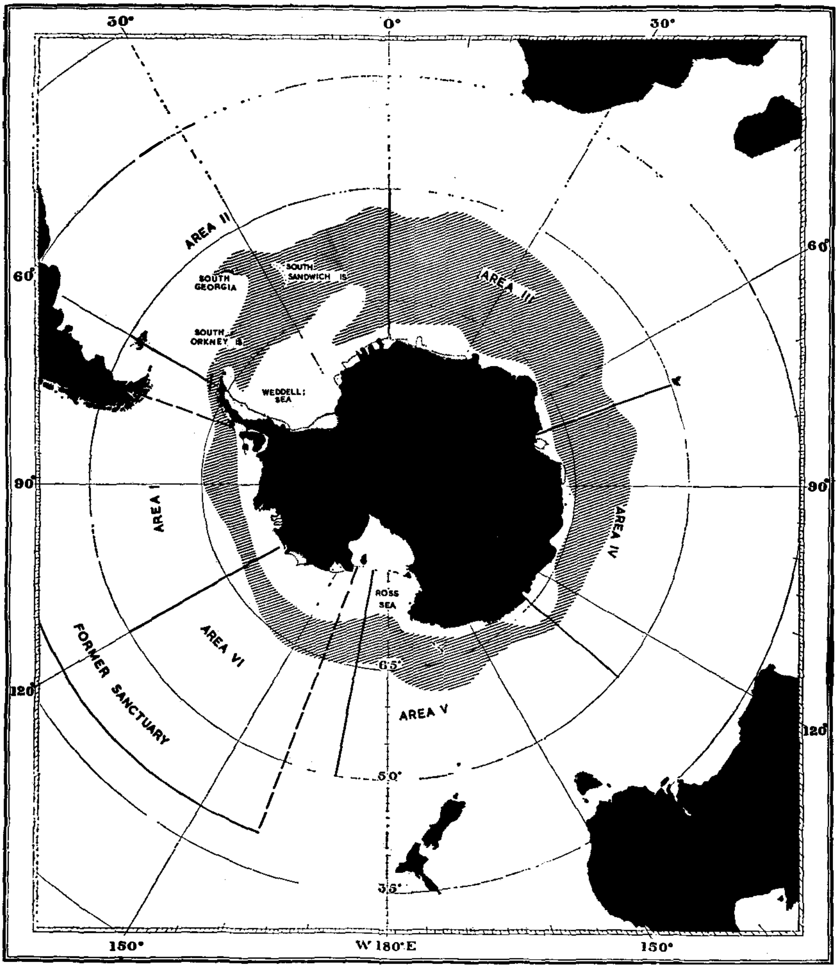

Figure 1. The Antarctic whaling grounds and whaling areas (based on Mackintosh, 1942, fig. 2).

species listed in Table 1. A number of smaller and much less important species are taken, for which full catch statistics are not readily available; they are not considered in this paper.

Antarctic whaling dates from 1904 when rorquals were first exploited at South Georgia. Up to 1913 it was based on the humpback whale which was quickly depleted. The blue whale then supported the industry, and in 1931 a world catch of 43,130 whales were taken, the great majority blue whales, from which were produced over 600,000

TABLE 1. SPECIES OF MAJOR ECONOMIC IMPORTANCE

Baleen whales (Mysticeti)	Approx. maximnm length	World catch 1947-48* No.	%	World catch 1957-58* No.	%
Blue (*Balaenoptera musculus*)	100 ft.	7,157	16.6	1,989	3.1
Fin (*B. physalus*)	85 ft.	24,028	55.7	31,583	49.8
Sei (*B. borealis*)	50 ft.	1,573	3.6	5,551	8.7
Humpback (*Megaptera novaeangliae*)	50 ft.	515	1.2	2,918	4.6
Toothed whale (Odontoceti)					
Sperm (*Physeter catodon*)	60 ft.	9,850	22.8	21,433	33.8
Total		43,123	99.9	63,474	100.0

*From International Whaling Statistics, No. XLIII, 1960.

tons of oil. Over 93 per cent of this catch was taken on the Antarctic whaling grounds between the Antarctic Convergence and the ice-edge. Owing to over-production the market failed and since 1932/33 Antarctic pelagic whaling has been subject to restrictions.

The decline of the blue whale began about 1931 and increasing numbers of fin whales appeared in the catches; this has been the most important species in recent years.

In World War II the catch fell to a low level, and in post-war years whaling outside the Antarctic has increased, so that in 1957/58 the world catch was over 63,000 whales, of which some 62 per cent were taken in the Antarctic. The development of modern whaling has largely been the story of Antarctic pelagic whaling and it is mainly with this that I am concerned.

CONSERVATION MEASURES

Regulation of shore-based whaling is relatively straightforward, but with the development of a pelagic industry which can hunt whales wherever they are to be found, is independent of shore-facilities, and in which several nations participate, the problems become more pressing and can only be dealt with by international agreement.

After the disastrous effect on the industry of the over-production of 1931 a number of restrictions were introduced by voluntary agreements between Norwegian and British companies in 1932/33. The most important provision concerned the allotting of production quotas to the various companies. These were expressed in blue whale units (B.W.U.), based on the oil yield, one blue whale being deemed equal to 2 fin, 2½ humpbacks or 6 sei whales. Further cartel arrangements were put into effect in the following three seasons.

A number of international agreements were also concluded, the first, the 1931 Convention, on the initiative of the League of Nations. It was followed by the Agreements of 1937 and 1938. In 1931 the Bureau of International Whaling Statistics was created to collect and publish relevant data on the catches. These publications are an important source of material for population studies.

After World War II the machinery of regulation was greatly improved by the signing in 1946 of an International Convention for the Regulation of Whaling. It set up the International Whaling Commission, which holds its 12th annual meeting this summer. The Commission has scientific committees which discuss and report on relevant biological research and advise on conservation measures. It is empowered to fix an overall limit to the Antarctic pelagic catch. Initially this was 16,000 B.W.U. but now stands at 15,000 and is probably the most important achievement of the Commission. Unfortunately the Commission is not able to interfere with economic competition by allocating specific national quotas. Competition for the largest share of the limited catch has become wasteful and uneconomic and is not compatible with "the orderly development of the whaling industry," which was an important object of the Convention. Discussions on the subject of separate national quotas took place last year (independently of the I.W.C.) between representatives of the five nations actively engaged in Antarctic pelagic whaling, but they were not able to reach an agreement. As a result Norway and the Netherlands have withdrawn from the International Whaling Convention, and the total catch in 1959/60 probably will be substantially higher than in previous years. The implication of an increased catch from a declining stock (see below) needs no comment, since even a stable catch can lead to an accelerated decline.

Other steps have been taken to conserve whale stocks and the more important restrictions and regulations are set out below.

1. Adequate inspection to be maintained.
2. The taking of grey whales *(Eschrichtius gibbosus)* and right whales (Balaenidae) is prohibited, except by aborigines.
3. The taking of baleen whales is forbidden in certain areas, and the taking of blue and humpback whales in certain additional areas. By the 1937 Agreement a sanctuary area was declared in the Pacific Sector of the Antarctic (Fig. 1). In recent decades, virtually no whaling occurred in this extensive region until the 1955/56 season when it was opened to whaling in an attempt to reduce the pressure on stocks of whales in other sectors. Pelagic whaling is forbidden in the Southern Hemisphere north of 40°S.
4. There have been restrictions on the Antarctic pelagic whaling season for baleen whales. The opening date has been postponed year by year from October 20 in 1932/33 to January 7 in 1954/55. The opening date for blue whales was further postponed to January 16 in 1953/54, to January 21 in 1954/55 and to February 1 in 1955/56. This affords more protection to the

blue whale which has been seriously depleted. Owing to seasonal segregation fewer pregnant females are present on the whaling grounds later in the season, and the longer whales have been on the feeding grounds, the better is the oil production. The humpback whale which has been depleted and is particularly vulnerable may be caught during a season of only four days. The baleen whaling season closes on April 7 or earlier, for the length of the season is now dependent on the attainment of the quota and notification is given by the Bureau of International Whaling Statistics. In recent years the length of the season has been only 69 days for fin whales and 44 days for blue whales. In 1932/33 it extended over 177 days. Minke whales *(Balaenoptera acutorostrata)* and sperm whales may be taken during an open season of six or eight months respectively.

5. The whaling season for land stations is eight months or less.
6. It is forbidden to take or kill whales below certain minimum lengths fixed for each species.
7. Provision is made for full utilization of the whales.

In view of the exceptional difficulties that arise in the regulation of a world-wide industry prosecuted on the high seas by several countries, the International Whaling Commission has been relatively successful, and depletion would certainly have been much more rapid and catastrophic without the restraint it has imposed. The main reasons why the Commission has not been more successful are politico-economic, but technical difficulties and in particular lack of adequate biological knowledge have been important contributory causes.

The technical difficulties and the short season have made it impossible to fix species quotas. For the humpback whale an annual pelagic Antarctic quota of 1250 is accepted as suitable, and the four-day open season is an attempt to achieve this, but in 1959 for example 2394 humpbacks were taken in the four days. With a fixed overall quota of blue whale units attempts to reduce the blue whale catch (by shortening the open season) result in a greatly increased catch of fin whales, because for every blue whale not taken, two fin whales (or six sei whales) are taken. Average oil prices rose steadily from about £12 a ton in the early 1930's to a maximum of £114 a ton in 1951 and have since declined. The margin between profit and loss for the industry is now very small, and reduction of the quota is not acceptable without a concommittant reduction in costs. Efforts in this direction have so far been unsuccessful owing to competition for the largest share of the catch.

There are no urgent conservational problems concerning the smaller toothed whales. Only the sperm whale is sufficiently important to be exploited on a large scale and for this species rational exploitation and conservation is easier than for the baleen whales. The main stocks keep to warmer waters; only male sperm whales are present in polar waters, and in other areas the females, which are much smaller, can be protected by a minimum-size regulation if strictly observed. However, in part of the Pacific females exceed males in the catches. The annual world catch has increased from a few thousand before World War II to 7,546 in 1946/47 and to 21,433 in 1957/58. It is now second in importance to the fin whale (Table 1). There is insufficient evidence to show whether or not depletion of the stocks of sperm whales is taking place, but at the present increasing rate of exploitation it can hardly be long deferred.

However the biological problems connected with the baleen whales have been, and still are more pressing and I intend to discuss some of these in more detail, dealing in particular with the blue and fin whales, and with Antarctic pelagic whaling.

SOME BIOLOGICAL PROBLEMS

1) *General*

From a morphological and physiological point of view few would disagree that whales are on the whole the most peculiar and aberrant of mammals (Simpson, 1945). They also have some claim to this distinction on ecological grounds, for they have lost all close ties with land. Their large size, very wide geographical distribution, remoteness and general inaccessibility present basic difficulties which are not met in other groups of exploited animals and make a formidable combination. The cost of an adequate research programme is prohibitive.

The growth rates and mature size of northern and southern hemisphere whales are very different (*e.g.* Jonsgård, 1952) and the annual cycle is six months out of phase, so interchange between them is unlikely and has not been demonstrated. Baleen whales do, however, undertake very long seasonal migrations. The evidence comes from the seasonal distribution of catches, whale marking (by means of numbered darts), studies of the sexual cycle, occurrence of parasites and skin diatom film, and observations from research ships (Mackintosh, 1942). In summer they feed in polar or sub-polar waters on swarming planktonic animals, and move northwards to warmer latitudes where breeding takes place in winter. Gestation lasts about a year, and the calves are born in tropical or sub-tropical waters (Laws, 1959a).

The humpback, fin, and blue whales have a similar distribution on the feeding grounds, but the sei whale does not penetrate into such cold waters. The humpback is markedly coastal in its breeding behaviour but the other more closely related species are oceanic in distribution. Although this means that the humpback is especially vulnerable to depletion, having been taken at points along its migration routes (Ruud, 1952), it also facilitates biological studies. Research on fin and blue whales must be largely confined to polar waters where the major whaling grounds are situated (Fig. 1).

This basic breeding and feeding rhythm is at the root the most serious of the problems which confront us.

2) *Composition of the Catches*

The annual publications of the Bureau of International Whaling Statistics provide valuable information on the composition of the catches in respect of species, sex, length, maturity, time and geographical distribution. Unfortunately in whales growth in length is very variable and there are many age groups, so length statistics are useful only in a general way. They cannot give a very precise idea of the changes in the age composition of the catches.

Much effort has gone into finding reliable methods of age determination and three complementary methods are in use, based on the interpretation of ridges on the baleen plates (Ruud, 1945), the accumulation of corpora albicantia in the ovaries (Wheeler, 1934; Laws, 1958) and laminations in the ear plug (Purves, 1955). For toothed whales growth layers in the teeth are available (Laws, 1953). These methods indicate that whales are long-lived and that the catches may be drawn from as many as fifty age groups.

Whales are so large that material for age determination and other studies has to be collected while the animals are being rapidly dismembered on the deck of the factory ship. Here again there are unique difficulties, but the samples we obtain, though smaller than one would wish, are representative of the catches.

The next step is to relate the data on the catches to the stocks in the sea, and here we meet certain difficulties which there seems little prospect of overcoming with our present resources.

3) *Segregation in Time*

Of necessity biological research has been largely concentrated on the populations of baleen whales present on the polar feeding grounds in summer; as material can only be obtained with the cooperation of the whaling companies the quality of the samples depends on variations in the length of the whaling season and on the intensity of whaling month by month. The present short open season for fin whales covers only part of the time when they are present on the feeding grounds; this is even more true in the case of blue, and especially humpback, whales with their shorter open seasons.

On their long migrations the various species travel at different times, so that blue and humpback whales appear on the feeding grounds in peak numbers before fin whales, and sei whales arrive later still (Mackintosh, 1942). Within a species there is a similar segregation. In the fin and blue whales the oldest animals appear on the feeding grounds first, younger animals next and the youngest last of all (Wheeler 1934; Mackintosh, 1942). Similarly the oldest females leave the feeding grounds first and mate earlier in the breeding season in warmer waters, and the younger animals migrate northwards and breed later (Laws, 1959b).

The period when samples are taken may therefore have a profound influence on their age composition, probably at all points along the migration routes, and certainly in Antarctic waters. For example, if separate survival curves are constructed for monthly samples taken in November, December, January, February and March, the slope is found to be steeper with the progression of the season (Laws, unpublished). A survival curve which does not include animals taken in representative numbers from the population present on the feeding grounds in the earlier and later months, should therefore give an apparent survival curve which differs from a real survival curve for the stock in the sea. The minimum length regulations also mean that the youngest age groups are under-represented, but this is less important for we can construct our survival curves so that they start at the age group which is most abundant in the catches.

Until we can be sure of the exact relation between the catch and the real population it is unrealistic to attempt to calculate precise mortality rates from the curves. We may with profit study relative changes in mortality rates or in the shape of survival curves if we ensure that the data are directly comparable from year to year. In practice I have taken January, February and the first half of March, as a standard period for comparison of annual samples of fin whales, because this represents the short whaling season of recent years. If the period is further shortened then the sample sizes become too small for statistical purposes.

4) *Geographical Segregation*

It has long been known that there is a geographical segregation of the southern stocks of baleen whales into more or less separate geographical groups or races. The results of whale marking show that the distribution on the feeding grounds is not random and that many whales return after their migrations year after year to the place of

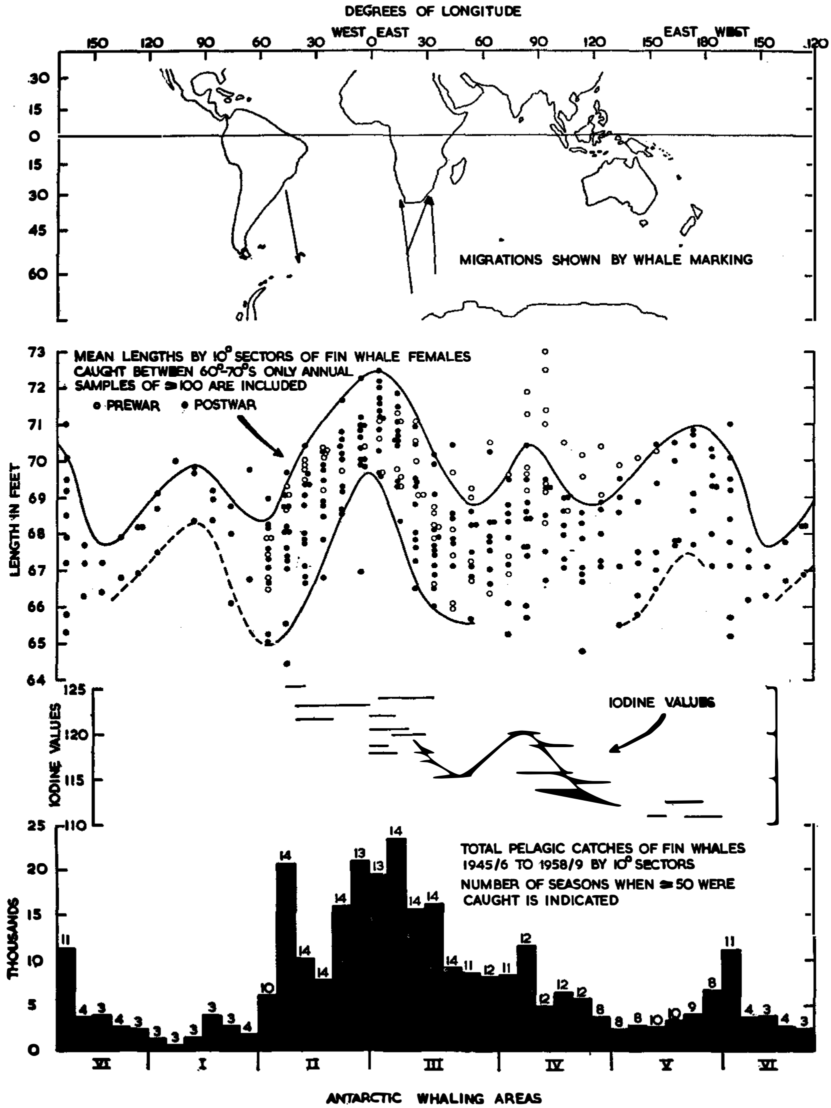

Figure 2. Some of the evidence for the existence of geographical groups or races in fin whales.

marking (Brown, 1954). In the case of the humpback whale depletion in one region (e.g. the South Atlantic) has had little if any effect on the populations in other regions (e.g. the Australian stocks).

Hjort, Lie and Ruud (1932) divided the antarctic whaling grounds into five areas (I to V) based on the distribution of the catches, mainly of blue whales, by Norwegian expeditions. In subsequent papers they confirmed the validity of this division. Mackintosh (1942) examined the distribution of blue, fin and humpback whales, partly on the basis of observations from research ships. He suggested the extension of area I and proposed a new area VI to include the rest of the Pacific Sector (Fig. 1). This terminology is now in general use, but it was based largely on the distribution of the catches of blue whales, which in prewar years were commercially the most important, and on the distribution of humpback whales. In prewar years the fin whale catches were influenced by the distribution of blue whales.

Since 1945 the fin whale has been the most important species and the post-war distribution of catches (Fig. 2) suggests that the whaling areas I to VI are not entirely valid for this species. In particular there is no good evidence for the view that the stocks of fin whales in areas II and III are distinct, but rather the contrary.

This view is supported by other evidence, in particular by a study of the length distribution of the catches (Fig. 2). This work is incomplete as yet, but in view of the important bearing it has on the interpretation of other material I must briefly summarize the more important results.

From data kindly supplied by the Bureau of International Whaling Statistics I have plotted the length distribution of the catches between 50°-60°S. and 60°-70°S. latitude over a long period of years, by 10° sectors of longitude. Both male and female material show a similar pattern but in figure 2 only the data for female catches between 60°-70°S. are shown. It is strikingly apparent that there is a size segregation by longitude, and that there appear to be four main groups or races, roughly corresponding to the South Atlantic, South Indian, West Pacific and East Pacific Oceans. The data for areas II and III present the clearest picture, and this is attributed to the greater area of the whaling grounds in this sector, associated with the asymmetrical Weddell drift (Deacon, 1937). Only in this sector have appreciable catches been made in 50°-60°S. These do not show such a marked length segregation with longitude, and prompt the suggestion that the pattern in 60°-70°S. is the result of size segregation on the feeding grounds, related perhaps to food and oceanographic conditions. In other sectors where the whaling grounds are much narrower (Fig. 1) 60°-70°S. is roughly equivalent to 50°-70°S. in the Atlantic sector, and the pattern shown in higher latitudes may be partly masked.

The size distribution is fairly closely correlated with the distribution of the catches. Within each group the largest animals are correlated with the greatest intensity of catching and there is a progressive decline in body size, and presumably in the density of the population in the sea, east and west of the modes. The largest animals and the greatest intensity of whaling occur on the Greenwich meridian at the boundary between areas II and III.

In Figure 2 a series of iodine values of whale oil from different areas are plotted. These are said to be closely correlated with the feeding conditions (Lund, 1950) and there appears to be a fairly clear correlation between these iodine values and the supposed racial groups, at least in areas II, III and IV. This supports the inference that the distribution of whales on the feeding grounds is closely related to the distribution and abundance of whale food.

The limited direct evidence of migrations between high and low latitudes provided by whale marking suggests that the continuous, and apparently homogeneous, summer feeding population in areas II and III may be drawn from whales which come from separate breeding grounds as far apart as the Indian Ocean and East and West Atlantic Ocean (Fig. 2, and Brown, 1959). The length-at-age data for fin whales taken in area I are so much lower than for area II (Purves and Mountford, 1959) that it seems clear there is a smaller geographical race frequenting area I. Marking returns and other data suggests that it is drawn from animals which breed in waters to the east and west of South America. Brown (1954) has however shown that there may be a significant interchange of animals between Antarctic areas I and II.

The significance of this kind of geographical segregation in relation to sampling and population problems is obvious, and further work is planned or in progress. The size segregation may reflect a segregation by age (though not necessarily) which would have important implications for the construction of survival curves and other aspects of population dynamics.

EVIDENCE OF DEPLETION

I have now indicated the magnitude of some of the problems which have to be overcome before we can really understand whale population dynamics. The concensus of opinion among scientists connected with the International Whaling Commission is that the stocks are in danger with a catch limit as high as about 15,000 B.W.U. There are however formidable difficulties in lowering the quota. The Commission is required to "take into account the interests of . . . the whaling industry." It is dealing with whaling on the high seas and limitation can only be by voluntary agreement.

What is the evidence of depletion and how much weight should we

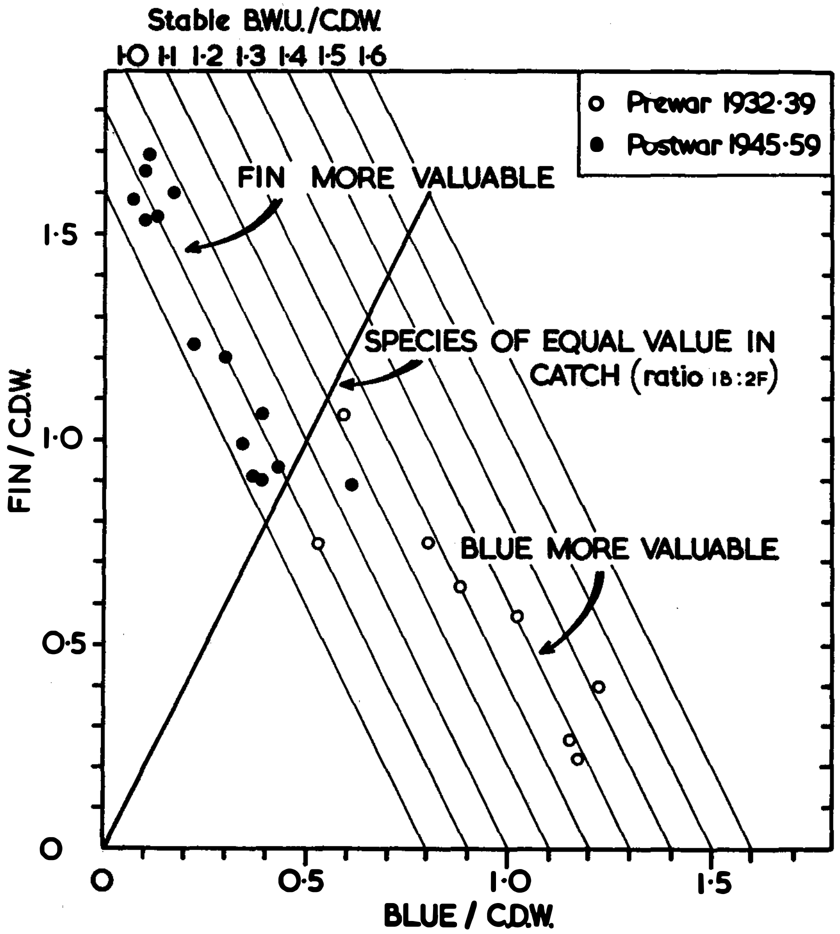

Figure 3. Relation between the catches of blue and fin whales per C.D.W.

attach to it? Clearly there is insufficient space for a detailed presentation here and I can do no more than summarize some of the more important arguments. Fuller accounts of this evidence are given by Ruud (1952), Laws (in press), Hylen, Jonsgård, Pike and Ruud (1955) and Ottestad (1956).

Owing to practical difficulties and to certain of the features of whale biology which I have discussed earlier, it has not been possible to make really confident estimates of the absolute changes in the size of the whale stocks. From a series of direct observations from research ships between 1933 and 1939 it has been estimated that the number of fin whales in the southern stocks at that time was about a quarter of a million (Mackintosh and Brown, 1956). This at least gives us some idea of the order of magnitude of the stocks.

In whaling statistics the catcher's day's work (or C.D.W.) is used as a unit of effort and whales per C.D.W. as a measure of relative abundance. The main disadvantage is that catcher efficiency has been steadily increasing so that the C.D.W. is not constant, nor is there much prospect of correcting for the variations. In spite of this it remains the most acceptable measure of effort and we can at least conclude that if the catch per C.D.W. is stable or decreasing while at the same time the average catcher efficiency is increasing, then the stocks are decreasing in abundance. Figure 3 shows that wide variations in the species composition of the catch may be associated with only slight changes in the catch of B.W.U. per C.D.W.

In an industry based on searching, which concurrently takes several species in varying proportions, changes in the catch per unit effort are influenced by the amount of effort being expended on the catch of other species. The small catches of humpback, sei, and sperm whales (in the open season for baleen whales) may safely be ignored in this context leaving two species, the fin whale and the blue whale.

In Figure 3 the annual values of fin whales per C.D.W. are plotted against blue whales per C.D.W. It shows that in pre-war and post-war seasons, as the number of blue whales declined there was a rise in the number of fin whales per C.D.W.

This changing species composition of the catch has masked changes in the stocks of fin whales until recent seasons, but since 1955/56 there has been a stable or decreasing value of fin whales per C.D.W. although the catch of blue whales has been very small. The effect of blue and humpback whales can be completely removed by comparing only data from January for 1955/56 onwards (when no blue or humpback whales have been taken in January). There is again a stable or decreasing value of fin per C.D.W., although catcher efficiency has continued to increase. From 1955/56 to 1958/59 the average catcher horsepower has increased by 23%.

We must conclude that the stocks of fin whales as well as those of blue whales are declining.

This conclusion is supported by the evidence of the changing composition of the catches of individual species, as regards average length and the relative proportions of different age groups.

The yearly mean lengths of fin and blue whales in the catches over the last three decades are shown in Table 2. Several factors must be taken into account in the interpretation of the decline in the mean length which the data indicate. In the early years the high mean lengths are probably the result of selection, but this bias later disappeared with the increased competition. The changes in the minimum length regulations and the later season also affect the mean lengths of the catches, but even when all these factors are taken into account, there can still be little doubt that the mean length of the stocks has decreased.

TABLE 2. MEAN LENGTH OF WHALES KILLED, AND PERCENTAGE SEXUALLY IMMATURE. ANTARCTIC PELAGIC WHALING.

	Mean length (ft.)		% sexually immature			Mean length (ft.)		% sexually immature	
Season	Blue	Fin	Blue	Fin	Season	Blue	Fin	Blue	Fin
1931/32	84.0	70.0	8.1	12.1	1947/48	78.4	67.9	28.6	13.8
1932/33	80.4	68.7	16.8	12.4	1948/49	79.1	67.9	23.5	14.6
1933/34	80.5	69.0	14.5	10.3	1949/50	79.0	67.5	23.1	17.9
1934/35	78.6	67.6	28.6	18.9	1950/51	78.2	66.6	29.4	23.9
1935/36	77.8	67.7	31.3	17.3	1951/52	78.0	67.9	35.1	16.6
1936/37	77.5	67.8	33.4	15.2	1952/53	77.5	67.3	39.1	22.1
1937/38	78.4	67.9	28.5	15.8	1953/54	78.0	67.1	36.5	21.9
1938/39	78.1	67.2	30.8	21.2	1954/55	77.8	66.5	37.7	27.3
1939/40	78.2	67.3	29.5	20.0	1955/56	77.3	66.5	39.8	25.7
1940/41	77.9	66.3	35.2	28.2	1956/57	77.0	66.9	38.5	25.0
1945/46	78.3	67.5	24.9	14.3	1957/58	77.1	66.2	38.5	30.6
1946/47	78.3	67.4	26.5	16.5	1958/59	78.3	66.3	33.2	30.0

The percentage immature in the catches (Table 2) is calculated from the length statistics, on the assumption (based on earlier biological studies) that on average male and female blue whales respectively 73 ft. or less and 76 ft. or less are immature. For fin whales the corresponding lengths are 62 ft. and 64 ft. Again, after making due allowance for changing conditions, there has been a substantial increase in the proportion of young animals. Other data on the age composition of samples of the catches support this and suggest an even greater increase in the proportion of young animals than is implied by the length statistics of the total catches.

It can be shown that the average age at puberty has decreased, probably in association with an increase in the growth rate, and that the fertility of adult females has increased. Both of these responses to increased exploitation in post-war years became stabilized at a new level by about 1953, and cannot account for the progressive increase in the number and percentage of young whales in the catches. It must therefore reflect a progressive reduction in the number of adult whales in the stock, and since in whales (which are monotocous) recruitment is directly related to the size of the adult female component of the stock, it follows that recruitment is also declining.

This limited summary can do little more than to suggest the nature of some of the evidence which indicates that the stocks are still endangered. There can however, be little doubt that depletion would have been much more rapid and catastrophic without the restraint imposed by the International Whaling Convention.

CONCLUSIONS

Whaling is an industry which is carried out on the high seas by nationals of several countries and is therefore amenable only to international control. It presents difficulties which are probably as great as any that have to be met in the conservation of other exploited animal groups.

The conservation measures introduced have been far reaching and in many respects relatively successful. The most important was the introduction of an overall catch quota in post-war seasons. The technical difficulty of regulating quotas for individual species means that a fixed quota in B.W.U. has allowed progressive depletion of the blue whale stocks, concurrently with an increasing catch of fin whales. It has not been possible to lower the quota because the catching capacity of the industry is already out of balance with the present quota and the profit margin is now small. The only real solution is to fix separate national quotas to eliminate wasteful competition, and then to reduce them gradually.

The biological problems in the regulation of whaling are substantial. They stem primarily from the large size, wide geographical distribution and the migratory pattern. There is a segregation of the different age groups in the populations, both in time and space, so that the whaling operations probably do not take a random sample of the stock. Real progress has been made in the development of precise methods of age determination and we are beginning to understand the broad pattern of whale population dynamics, but until it is possible to extrapolate with certainty from the catches to the population in the sea, the condition of the stocks must be examined in a comparative way. This makes it difficult to obtain quantitative evidence of depletion.

LITERATURE CITED

Brown, S. G.
1954. Dispersal in blue and fin whales. *'Discovery' Rep.* 26, 355-384.
1959. Whale marks recovered in the Antarctic seasons 1955/56, 1958/59 and in South Africa 1958 and 1959. Hvalfangst-tidende, 1959, no. 12, 609-616.

Deacon, G. E. R.
1937. The hydrology of the southern ocean. *'Discovery' Rep.* 15, 1-124.

Hjort, J., J. Lie, and J. T. Ruud
1932. Norwegian pelagic whaling in the Antarctic I. Whaling grounds in 1929-1930 and 1930-1931. Hvalrad. Skr. nr. 3, 1-37.

Hylen, A., A. Jonsgard, G. C. Pike and J. T. Ruud
1955. A preliminary report on the age composition of Antarctic fin whale catches 1945/46 to 1952/53 and some reflections on total mortality rates of fin whales. Hvalfangst-tidende, 1955, no. 10, 577-589.

International Whaling statistics, 1931-1959.

Jonsgard, A.
1952. On the growth of fin whales in different waters. Hvalfangst-tidende, 1952, no. 2, 57-65.

Laws, R. M.
1953. The Elephant Seal (*Mirounga leonina* Linn.). I. growth and age. Sci. Rep. Falkland Islands Dept. Surv. 8, 1-62.
1958. Recent investigations on fin whale ovaries. Hvalfangst-tidende, 1955, no. 5, 225-254.
1959a. The foetal growth rates of whales with special reference to the fin whale, *Balaenoptera physalus* Linn. *"Discovery' Rep.* vol. 29, 281-308.
1959b. On the breeding season of Southern Hemisphere fin whales, *Balaenoptera physalus* (Linn.). Hvalfangst-tidende, 1959, No. 7. 48 Arg., (7) 329-351.
(In press) Some effects of whaling on the southern stocks of baleen whales. Brit. Ecol. Soc., Symposium on the Exploitation of Natural Animal Populations. 1960.
Lund, J.
1950a. Charting of whale stocks in the Antarctic on the basis of iodine values. Hvalfangst-tidende 1950, no. 2, 53-60.
1950b. Charting of whale stocks in the Antarctic in the season 1949-50 on the basis of iodine values. Hvalfangst-tidende 1950, no. 7, 298-305.
Mackintosh, N. A.
1942. The southern stocks of whalebone whales. Discovery Rep., 22, 197-300.
Mackintosh, N. A., and S. G. Brown
1956. Preliminary estimates of the southern populations of the larger baleen whales. Hvalfangst-tidende 1956, no. 9, 469-480.
Ottestad, P.
1956. On the size of the stock of Antarctic fin whales relative to the size of the catch. Hvalfangst-tidende, 1956, no. 6, 298-308.
Purves, P. E.
1955. The wax plug in the external auditory meatus of the Mysticeti. 'Discovery' Rep. 27, 293-302.
Purves, P. E., and M. D. Mountford
1959. Ear plug laminations in relation to the age composition of a population of fin whales (*Balaenoptera physalus*). Bull. Brit. Mus. (nat. hist.) Zoology, 5, (6) 123-61.
Ruud, J. T.
1945. Further studies on the structure of the baleen plates and their application to age determination. Hvalrad. Skr. No. 29:1-69.
1952. Modern whaling and its prospects. Hvalfangst-tidende 1952, no. 12, 649-660.
Simpson, C. G.
1945. The principles of Classification and a Classification of the Mammals. Bull. Amer. Mus. Nat. Hist. 85, 1-350.
Wheeler, J. F. G.
1934. On the stock of whales at South Georgia. "Discover" Rep. 9, 351-372.

DISCUSSION

MR. JAHN [Wisconsin]: In connection with the whale catch, is there any distribution in connection with a quota system to the various countries?

MR. LAWS: This is the point on which the convention seems to be foundering. There have been discussions in the last two years between the different countries participating in Antarctic pelagic whaling—actually five countries—but they have not been able to agree on the distribution of the quota. Norway proposed an average of the previous years' catches, but other countries claim that their industries were expanding and, that this was not a fair way of deciding the quotas. In fact, no agreement has been possible.

CHAIRMAN BARTHOLOMEW: Do the shore fisheries in this country and in Australia have any particular role in the over-all depletion of stocks?

MR. LAWS: The shore fisheries in this country, I think, do not have any important influence. In Australia, they take mainly humpback whales, and there is increasing evidence that the stocks are declining. They, of course, are taken at both ends of the migration route, both in low latitudes off Australian coasts and in the Antarctic waters during the pelagie whaling season.

MR. LOGER [Michigan]: Is there enough known about whales now in order to give information on your class dominance or original cycles of population?

MR. LAWS: We have these very reliable methods of age determination but thus far there is no evidence that one does get dominant year classes. I don't think this is very surprising in view of the nature of the reproductive cycle and population turnover, which is rather slow compared with most other mammals.

ROLE OF ESTUARINE WATERS IN GULF FISHERIES

BERNARD E. SKUD AND WILLIAM B. WILSON
Biological Laboratory, U. S. Bureau of Commercial Fisheries, Galveston, Texas

The commercial fisheries of the Gulf of Mexico have experienced a phenomenal growth during the past 20 years. In 1940 landings of the Gulf states, Florida (west coast), Alabama, Mississippi, Louisiana and Texas totaled 250 million pounds valued at 10 million dollars and increased to 700 million pounds valued at 85 million dollars in 1957 (Figure 1). In 1940, the Gulf accounted for only 10 percent of the total value of U. S. fisheries and in 1957 accounted for nearly 25 percent of the U. S. total. In value, three Gulf states are included among the ten leading states, Texas ranks third in the nation and Florida and Louisiana follow in fifth and eighth place respectively (Power, 1959).

The growth of the Gulf fishery has several facets of interest. One is that the fishery is conducted in shallow coastal waters, contrasted with open ocean fishing such as for tuna and groundfishes. Another facet is that the species contributing to this fishery are all ''estuarine-dependent''. That is, at some period of their life, these species inhabit intra-coastal waters such as bays, lagoons and marshes of the Gulf. (Present-day usage of estuary often includes all areas in which there is daily mixing of fresh and saline waters in contrast to the more restricted definition of tidal-river mouths. For lack of a better term, we consider the term estuary as synonymous with all intra-coastal waters).

The purposes of this paper are to: (1) show the contribution of estuarine-dependent species to the commercial fisheries of the Gulf of Mexico, (2) outline some of the environmental features of the estuary and (3) give examples of man-made changes which influence this environment.

ESTUARINE ECOLOGY

Estuarine-dependent species such as shrimp, menhaden and oysters dominate the Gulf fishery, and account for approximately 90 percent of the annual fisheries value. These estuarine-dependent species can be separated into two general categories—transients and residents. Of the commercially important species, the majority are transients and are represented by fishes such as menhaden *(Brevoortia)* and mullet *(Mugil)* and by invertebrates such as shrimp *(Penaeus)*. These particular species may be referred to as ''quasi-catadromous'' in that the adults spawn offshore and the young move inshore to less saline estuarine waters. Oysters *(Crassostrea)* characterize the resi-

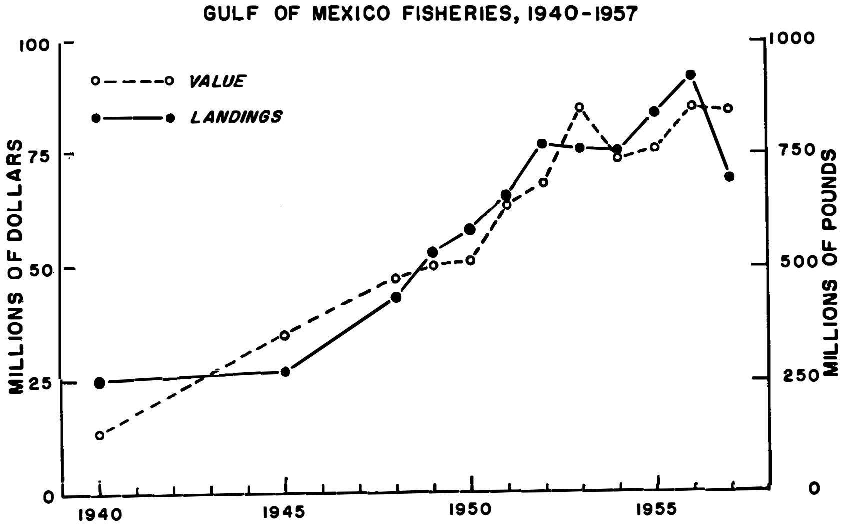

Figure 1. Landings and value of Gulf fisheries, 1940-1957.

dent species and spend their life within the estuarine boundaries.

The life history of shrimp exemplifies the existence of the transient organisms. Adult shrimp spawn offshore and their post larvae enter the estuaries through passes between barrier islands and move to the estuarine nursery areas. These nursery areas may be lesser bays, lagoons, marshes, or bayous. Within a period of approximately three months, following growth and development to juveniles or immature adults, the shrimp migrate through the passes into the open Gulf.

Several species of penaeid shrimp contribute to the Gulf fishery and it is of interest to note the progression in habitat use of two of these species. In Galveston Bay, Texas, white shrimp (*Penaeus setiferus*) and brown shrimp (*P. aztecus*) inhabit the same general areas but do so during different seasons of the year (Chin, 1959). Brown shrimp dominate in the spring and whites in the summer and fall. The brown shrimp remain in the estuary for shorter periods and migrate seaward at smaller sizes than the white shrimp. Our knowledge of shrimp physiology, behavior, population dynamics and ecology is not well enough advanced so that we can outline the precise role of estuarine waters and their influence on shrimp populations.

The life history of the oyster, a resident species of estuaries, has been summarized by Butler (1953) and Hofstetter (1959). Oysters spawn in the bays from May to September. The eggs and larvae develop rapidly and within approximately two months the larvae must find a suitable surface for attachment. If successful, they become permanently sessile adults. Because of its ability to adapt to varying environmental conditions, the oyster is a common species of many Gulf estuaries.

How important are the estuaries to our fisheries and how are the fisheries affected by natural and man-made changes? Attempts to answer these questions emphasize our limited knowledge about estuaries. We shall present some of the results of research that have given insight to the complexity of the estuarine environment and its potential value to the Gulf fisheries.

Gulf estuaries normally result from the formation of offshore bars, although many occur in deltaic formations. They are funnel or oval shaped and the majority have maximum dimensions of less than 15 miles. Although depth-sections reveal shallow, depression shapes, most Gulf estuaries are transected by oyster reefs and sand bars. The average depth is usually less than 10 feet. According to Shuster (1959), such shallow bodies of water are extremely productive as most of their volume is exposed to high light intensities. Additionally, the bottom itself is exposed to strong light, affording a greater area for growth of sessile plants.

The estuarine tides of the Gulf are of small amplitude, generally less than two feet. Irregular changes of water level of greater magnitude are caused by winds. The latter changes are probably the most important in the water interchange of these estuaries and wave action stirs the bottom redistributing the nutrients.

The majority of the Gulf estuaries are within salt marshes or have marshes around much of their periphery. In effect, the marshes extend the shoreline and the producing area of the estuary. Nutrients are flushed from the marshes into the estuaries, and many estuarine organisms periodically forage in the marshes. Starr (1956) describes the importance of marshes as areas of vitamin B_{12} production and Provasoli and Pintner (1953) lists vitamin B_{12} as a growth requirement of phytoplankton organisms.

Measurements of primary productivity show that estuaries are more productive than the continental shelf and deep oceans and often exceed certain agricultural areas, grasslands and shallow lakes (Odum, 1959). The summer productivity was at least 1.5 times that of winter in Gulf estuaries and the greater number and poundage of macroorganisms was present during the summer period (Odum, personal communication).

In these shallow estuaries, changes in water temperature occur rapidly; summer temperatures as high as 88° F. and winter temperatures as low as 45° F. are not uncommon. Changes of 20° F. within a five-day period may occur in the winters. Rapid temperature changes have caused the death of millions of marine organisms (Gunter, 1941).

In regard to salinity, Gulf estuaries are of two general types. First is the hypersaline estuary in which the salinity varies from approximately $36^{0}/_{00}$ of the open Gulf to $80^{0}/_{00}$ or higher in the innermost areas. The second is that in which the salinity varies from less than $1^{0}/_{00}$ in the headwaters to between 20 and $35^{0}/_{00}$ near the mouth. Most estuaries are in the second group. Changes of this magnitude limit the number of species which inhabit given portions of the estuary. Many authors, for example, Ladd (1951) found that the number and abundance of mollusk species were higher in polyhaline bays and passes (salinity—$15\text{-}31^{0}/_{00}$) than either in the Gulf (salinity over $32^{0}/_{00}$) or in the closed bays and headwaters (salinity less than $15^{0}/_{00}$). Mackin and Wray (1949) state that of all basic environmental factors, salinity has the greatest influence on oyster mortality. Their statement is qualified by the remark that high salinity alone does not produce death, rather, mortality follows the infestations and/or infections of shell pests, predators, and parasites that require high salinity for optimum development. Thus in low-salinity, estuarine waters the incidence of oyster mortality from these causes is much reduced. In spite of this relation, salinity *per se* does not seem to be the exclusive limiting factor.

The inflowing freshwater is one of the principal sources of nutrients in estuaries. Runoff varies from practically none in the Laguna Madre with no permanent streams entering it, to the tremendous flow of the Mississippi River. That the growth of estuarine phytoplankton depends upon nutrients from the land is shown by their increase following periods of heavy rainfall (Nash, 1947). Pratt (1949) states that fertilization of a salt-water pond increased the standing crop of phytoplankton as much as tenfold. Small, repeated applications caused a larger increase than a single large application. The organic detritus from marshlands and rivers is an important source of food. Indeed, some organisms may consume such detritus as their principal food source. This material is decomposed by bacteria and fungi and a large number of organic and inorganic substances are released (Odum, 1959).

MAN-MADE CHANGES

In addition to the natural-occurring changes, man in his progress has an ever-increasing influence on estuarine waters. Man-made changes include engineering structures on river basins flowing into the estuaries as well as dredging and channelization in the estuaries proper. These projects may alter the environment and affect the estuarine populations. For example, reduced outflow of a dammed river may reduce the nutrient supply or increase the salinity to the detriment of certain estuarine species. On the other hand, controlled outflow may stabilize the estuarine environment and provide conditions more favorable for a given species. Specific knowledge is not sufficient to interpret the results of the environmental changes. Pritchard's (1953) work on the distribution of oyster larvae in relation to hydrographic conditions exemplifies the need for such specific information and the coordinated efforts of physical and biological scientists. He showed that sub-surface currents influenced the distribution of oyster larvae and accounted for their concentration at the head of the estuary. However, the larvae exhibited some ability to remain grouped, independent of the circulation and mixing processes. He concluded that "... physical scientists, when attempting to apply physical theories to biological problems, must take into account the possible modifying factors peculiar to the organism involved. Some responsibility must then rest with the biologists to supply information concerning the organism which might modify the influence of the physical factors." Extensive planning and full understanding of the particular estuarine environment is necessary to determine the possible effects on biological populations.

In the past, municipal, industrial and agricultural uses of our water resources have been the major concern of water-use projects. However, during the development of these projects, the importance of other uses has become evident and the evaluation of effects has broadened in scope. For example, fishery and recreational uses must be considered and the evaluation must include more than the immediate project area to account for indirect or secondary changes. An instance of a secondary change was mentioned during a previous Conference (see Trans. Twenty-first No. Amer. Wildl. Conf. p. 436). The discussion concerned the Santee-Cooper hydro-electric project in South Carolina. An increased river flow in one system was expected to carry the accompanying sediment increase. However, on reaching the estuary, the suspended material settled into an upstream tidal flow and was deposited in the estuary, creating a dredging cost of a million dollars annually. Sedimentation changes such as this are of particular concern in the Gulf because of the shallowness of the estuaries.

As an example of the magnitude of these undertakings we can cite the Mississippi-Gulf Outlet Project of the Corps of Engineers. Already under construction, this project is designed to provide a 70-mile long navigable channel from New Orleans to the open Gulf. The channel is being dredged to a depth of 40 feet and a bottom width of 500 feet. It traverses a system of bayous, embayments and marshes on the eastern side of the Mississippi Delta, and crosses Breton and Chandeleur Sounds. Waters in the vicinity are fished commercially for shrimp, oysters, and industrial fishes. Current research on the prevailing hydrological and biological conditions will provide a basis for interpreting possible effects on commercial fishery resources.

Some progress towards integrated programs of evaluating the effects of these engineering projects is in evidence. Conservation agencies of each Gulf state, such as the Texas Game and Fish Commission, and the U. S. Fish and Wildlife Service review proposed projects and when applicable, submit recommendations to mitigate damages to marine and estuarine as well as freshwater populations. However, the existing scale of research must be accelerated to keep pace with the ever-increasing number of man-made changes in the estuaries.

SUMMARY

Fisheries of the Gulf of Mexico have increased in value from 10 to 85 million dollars and in weight from 250 to 700 million pounds during the past 20 years. Estuarine-dependent species such as shrimp, menhaden and oysters dominate these fisheries and account for 90 percent of the landed value. Shrimp and most fishes are dependent on the estuaries during the all important early phase of their life history. Oysters, on the other hand, complete their entire life cycle in the estuary.

Most Gulf estuaries can be characterized as variable environments, in which, the inhabitants must have broad tolerance limits. These shallow embayments are subject to rapid changes in such factors as temperature and salinity. Some estuaries are hypersaline but in most, the salinity varies from less than $1^0/_{00}$ to $25^0/_{00}$. River discharge and flushing of salt marshes are probably the principal sources of nutrients.

The number of man-made changes in the estuaries and inflowing streams is increasing rapidly and expanded research is sorely needed to evaluate the effects of such changes on the estuarine species.

LITERATURE CITED

Butler, Philip A.
1953. Summary of our knowledge of the oyster in the Gulf of Mexico. U. S. Fish and Wildlife Service, Fishery Bulletin, 55(89):479-491.

Chin, Edward
1959. Estuarine field studies. *In:* Fishery Research, Galveston Biological Laboratory, Fiscal Year 1959. U. S. Bureau of Commercial Fisheries, Circular 62. 127 pp.

Gunter, G.
1941. Death of fishes due to cold on the Texas coast, January, 1940. Ecology, 22:203-208.

Hofsetter, Robert P.
1959. The Texas oyster fishery. Bulletin, Texas Game and Fish Comm., No. 40. 38 pp.
Ladd, H. S.
1951. Brackish-water and marine assemblages of the Texas coast, with special reference to mollusks. Publ. Inst. Mar. Sci., Univ. Texas, II(1):125-163.
Machin, J. G. and D. A. Wray
1949. A study of mortality-producing agencies in Barataria Bay, Louisiana. Texas A. and M. Research Foundation, Project Nine. 38 pp. (Processed).
Nash, C. B.
1947. Environmental characteristics of a river estuary. J. Mar. Res., 6:147-174.
Odum, E. P. and H. T. Odum
1959. Fundamentals of Ecology. W. B. Saunders Co., Philadelphia. 546 pp.
Power, E. A.
1959. Fishery statistics of the United States, 1957. U. S. Bureau of Commercial Fisheries, Statistical Digest 44. 429 pp.
Pratt, D. M.
1949. Experiments in the fertilization of a salt water pond. J. Mar. Res., 8:36-59.
Pritchard, D. W.
1953. Distribution of oyster larvae in relation to hydrographic conditions. Proc. Gulf Caribb. Fish. Inst., 5th(1952):123-132.
Provasoli, L. and I. J. Pintner
1953. Ecological implications of *in vitro* nutritional requirements of algal flagellates. Ann. N. Y. Acad. Sci., 56:839-851.
Shuster, C. N.
1959. A biological evaluation of the Delaware River estuary. Information Series, Pub. No. 3, Univ. Delaware Mar. Lab. 77 pp.
Starr, T. J.
1956. Relative amounts of vitamin B_{12} in detritus from oceanic and estuarine environments near Sapelo Island, Georgia. Ecology, 37:658-664.

DISCUSSION

MR. RIGGS: [Oklahoma]: I am curious about the staining technique that you use.

MR. SKUD: The shrimp are injected with hypodermic needles. For the most part we have used a fast green and find it more successful than some of the other biological dyes. On injecting this into the shrimp, the entire body discolors immediately. However, within a 24-hour period, the stain settles in the gill, and we have recovered shrimp that have been held in the pond for as long as six months, and the stain is still recognizable in the gills.

CHAIRMAN BARTHOLOMEW: A problem on which I would like to have a brief discussion is the pollution of estuary waters by detergents.

MR. SKUD: Work on pollution of many sorts has been quite varied in the Gulf and I can give no evidence for work specifically concerned with detergents. Very little of this is known and further, as far as growth and vegetation in the estuaries, also very little is known.

MR. SIGLER [New Hampshire]: Have you done any work on the importance of estuaries on forage fishes which attract game fish?

MR. SKUD: I would only say indirectly. We are accumulating some information on forage and game fishes which inhabit the estuarine areas but nothing specific on forage fishes as such.

ABUNDANCE OF ST. JOHNS RIVER SHAD[1]

CHARLES H. WALBURG
Bureau of Commercial Fisheries, U. S. Fish and Wildlife Service, Beaufort, N. C.

Scientific management of our fishery resources to obtain optimum sustained yields has been the object of much fishery research in recent years. Management of fisheries to increase long-term yield is possible, at least for some species, as evidenced from West Coast research on the Pacific halibut *(Hippoglossus stenolepis)* and the sockeye salmon *(Oncorhynchus nerka)*, and from East Coast research on the shad populations of the Hudson and Connecticut Rivers. The success of these studies was dependent on knowledge of population size determined over a period of years. With these data, it was possible to conduct studies which were successful in determining causes for fluctuations in population abundance. The control of factors limiting population size, within desired levels, has led the way to successful fisheries management.

An investigation to determine the feasibility of managing the shad population of the St. Johns River, Florida, was begun in 1953. This program is part of a coastwise study of the American shad *(Alosa sapidissima)* begun by the U. S. Fish and Wildlife Service in 1950 and sponsored by the Atlantic States Marine Fisheries Commission.

LIFE HISTORY

The American shad is an anadromous fish which spends most of its life in the sea, but spawns in the fresh waters of our coastal rivers. The range of this species on the Atlantic Coast is from the St. Lawrence River in Canada to the St. Johns River in Florida. The spawning migration begins as early as November in Florida and as late as June in Canada. Females deposit their eggs loosely in the water where they are fertilized by the males. The number of eggs produced per female has been found to range from 116,000 to 660,000, depending on length, weight, and age of the fish. After absorbing water, the eggs sink to the river bottom where they are carried by the current. Hatching occurs in 6 to 8 days, depending on water temperature.

According to Talbot and Sykes (1958), shad native to streams north of Cape Hatteras, N. C., which survive spawning migrate to the sea and in successive years return to spawn again, provided they survive natural and fishing mortalities. Those fish native to streams south of Cape Hatteras die after spawning.

[1]This report embodies some of the results of a paper submitted for publication as a Fishery Bulletin, U. S. Fish and Wildlife Service, and includes additional data for 1959.

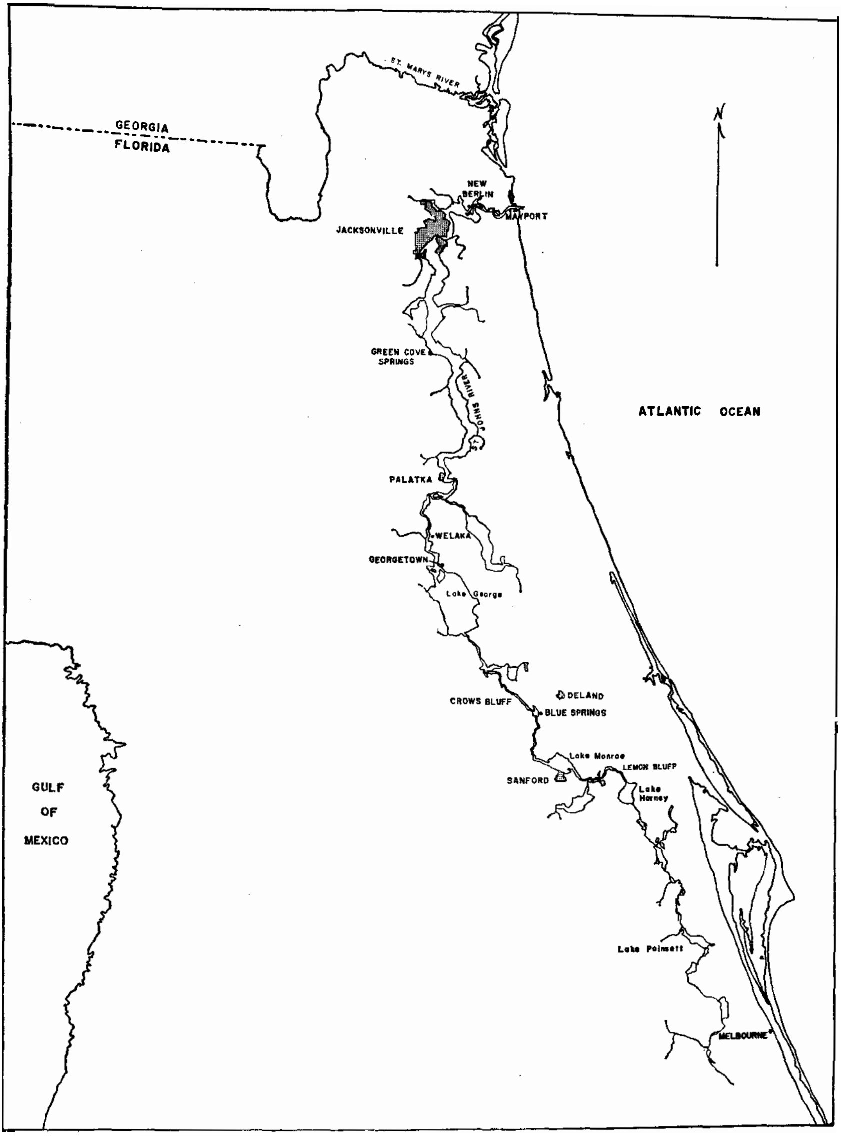

Figure 1. St. Johns River, Florida.

The young remain in the rivers until fall, at which time they are 3 to 6 inches in length, and then enter the ocean. The summer and fall months are spent in the Gulf of Maine and the winters in deep water off the Middle and South Atlantic Coast. After attaining sexual maturity, in 3 to 5 years, most shad return to the stream of their birth to complete the cycle. The age of shad and number of times they spawn can be determined from their scales (Cating 1953).

DESCRIPTION OF RIVER AND FISHERY

The St. Johns River originates about 50 miles north of Lake Okeechobee and 15 miles southwest of Melbourne, Florida. It flows north through a number of shallow lakes to Jacksonville and then east to the ocean for a total length of about 285 miles. In this river, shad fishing is limited to several well-defined areas. Anchor-gill nets are fished in the ocean in close proximity to the river mouth. Drift-gill nets are fished in the vicinity of both Jacksonville and Palatka. Haul seines (locally termed "shad nets") are fished between Palatka and Welaka. In addition to the commercial fishery, there is an extensive sport fishery for shad located between Lakes Monroe and Harney (Fig. 1).

Commercial fishing for this species did not begin on the St. Johns until 1858 when a fisherman from Connecticut began fishing near Mayport at the mouth of the river. In 1880, the first year in which total catch records are available, 252,000 pounds were reportedly caught (Table 1). Since that time the catch increased to a peak of

TABLE 1. COMMERCIAL CATCH OF SHAD IN THOUSANDS OF POUNDS, ST. JOHNS RIVER, FLORIDA[1]

Year	Catch	Year	Catch
1880	252	1939	254
1888	1,448	1940	344
1889	2,051	1941	256[3]
1890	2,654	1942	323[3]
1896	1,375[2]	1943	666[3]
1897	1,011	1944	811[3]
1902	1,819	1945	842
1908	2,833	1946	337[3]
1918	964	1947	625[3]
1923	503	1948	515[3]
1927	348	1949	284[3]
1928	691	1950	298
1929	701	1951	336
1930	880	1952	203
1931	621	1953	280
1932	546	1954	343
1934	782	1955	434
1936	282	1956	293
1937	288	1957	261
1938	299	1958	552
		1959	604

[1]Statistics 1880-1952 from Power (1958), except as noted. Statistics 1953-1959 this study.
[2]Catch in fish 1896 (Stevenson, 1899) converted to pounds by factor of 3.0.
[3]Catch data obtained by Florida State Board of Conservation.

2,833,000 pounds in 1908 and then decreased with minor fluctuations to a low of 203,000 pounds in 1952. Except for the period, 1953-1959, no data are available concerning the amount of fishing gear employed in making these catches, and therefore it is impossible to say whether fluctuations in catch were caused by changes in shad abundance, changes in fishing effort, or a combination of these factors.

POPULATION STUDIES

Since 1953 the U. S. Bureau of Commercial Fisheries has been studying the shad population of the St. Johns River. Each year catch and effort data have been obtained from both the commercial and sport fisheries. The commercial catch data are obtained from fish buyers who keep a daily record of all fish purchased. Data on the sport catch are obtained from several camp operators who keep a record of the number of their boats rented and the number of shad landed.

During the 1958 shad run an intensive tagging and recovery program was conducted in the upriver-haul-seine-fishing area to determine fishing rate and size of run available to this fishery. Normally a tagging study to estimate population size would be conducted near the river mouth. In this river, however, live fish suitable for tagging could not be obtained from the lower-river-gill-net-fishery, and therefore the study was conducted from haul seines. Throughout the fishing season, 950 shad were tagged with Petersen disk tags inserted directly below the origin of the dorsal fin. Care was taken that only vigorous fish were tagged, and therefore tagging mortality was considered negligible. Fishermen were contacted frequently during the fishing season in an effort to recover all recaptured tags. A 50-cent reward was paid for the return of each tag.

Ninety-seven of the fish tagged were recovered downstream by the gill-net fishery. The majority of these were taken in the Palatka area. Since the purpose of the tagging program was to determine the number of tagged shad available to the haul-seine fishery, these 97 tags were subtracted from the total tagged, leaving 853 available to the fishing gear. No tags were recaptured outside the river; therefore it was assumed that most, if not all, tagged fish that moved downstream immediately after tagging, eventually resumed their upstream journey to the spawning grounds. During the fishing season, 108 tagged fish were included in the 344,000 pounds of shad which were taken by the haul seines. The estimated fishing rate of these nets was 108/853, or 12.7 percent. Because of the small mesh size of the haul seines, all shad encircled by this gear were considered captured regardless of whether they were tagged or untagged, and therefore tag selectivity was nil.

An estimate of the number of shad available to the haul seine fishery was obtained by dividing the catch (344,000 pounds) by the calculated fishing rate (12.7 percent). The value obtained was 2,709,000 pounds. Ninety-five percent confidence limits on this estimate were calculated to be 2,223,000 and 3,260,000 pounds (Chapman, 1948).

The information obtained from the 1958 studies can be used to obtain estimates of the size of run available to the haul seine fishery for each year in which catch and effort data have been obtained, provided several assumptions pointed out by Ricker (1940) are satisfied. Analysis of data obtained from this investigation indicates that this was done. Using a method given by Talbot (1954), the fishing rate and number of shad available to the haul seines were determined for each year since 1953. Total effort, fishing rate, catch, and estimated size of run available to the haul-seine fishery are given in Table 2. Also shown in the table is the estimated size of the St. Johns River shad population for the years 1953-1959. This was determined by adding the number of fish caught by the gill-net fishery to the number available to the haul seines. From inspection of Table 2, it is evident that since 1953 both catch and population size have generally increased while fishing effort has generally decreased.

TABLE 2. CALCULATED NUMBER OF SHAD AVAILABLE TO THE HAUL-SEINE FISHERY AND ESTIMATED POPULATION SIZE, ST. JOHNS RIVER, FLORIDA

	Haul seine				Gill net	Population
Year	Effort (net-days)	Fishing rate (per cent)	Catch (thousands of pounds)	Size of run (thousands of pounds)	Catch (thousands of pounds)	size (thousands of pounds)
1953	785	22.1	201	910	79	989
1954	616	18.0	261	1,450	82	1,532
1955	492	14.5	381	2,628	53	2,681
1956	303	9.2	174	1,891	119	2,010
1957	224	6.9	182	2,638	79	2,717
1958	426	12.7	344	2,709	208	2,917
1959	481	14.3	392	2,741	212	2,953

Fish escaping the commercial fishery are still liable to capture by the upstream sport fishery. Sport fishing for shad on the St. Johns began in 1942. Since that time it has grown and at present is the largest sport fishery for this species on the Atlantic Coast. Shad are taken by hook and line from December through April; however, the best catches are made from mid-January to mid-March. A creel census conducted on this fishery in 1958 indicated that the catch was 65,000, or about 175,000 pounds of fish. This information, together with partial census data collected since 1953, was used to obtain estimates of the sport catch each year 1953 to 1959. The annual catch of shad in the St. Johns River was obtained by adding the commercial and sport catch for the same year. The number of shad not caught each year, termed the spawning escapement, was estimated by subtracting total catch from population size. Annual fishing mortality rate was obtained by dividing total catch by size of run. From Table 3 it can be seen that the sport catch has increased from 82,000 pounds in 1953 to 181,000 pounds in 1959. Total catch has generally increased from 362,000 pounds in 1953 to 785,000 pounds in 1959. During this same period, spawning escapement generally increased from 627,000 to 2,169,000 pounds. The annual fishing mortality rate decreased from 37 percent in 1953 to 15 percent in 1957, with an increase to 26 percent in 1959.

TABLE 3. POPULATION STATISTICS OF SHAD RUNS, ST. JOHNS RIVER, FLORIDA

Year	Sport catch (1,000 pounds)	Total commercial and sport catch (1,000 pounds)	Population size (1,000 pounds)	Spawning escapement (1,000 pounds)	Fishing mortality rate (per cent)
1953	82	362	989	627	37
1954	74	417	1,532	1,115	27
1955	90	524	2,681	2,157	20
1956	64	357	2,010	1,653	18
1957	140	401	2,717	2,316	15
1958	175	727	2,917	2,190	25
1959	181	785	2,953	2,169	26

DISCUSSION

Scientific management of the St. Johns River shad population to obtain optimum yields is not now possible because factors affecting size of run are unknown. A number of elements could have an effect on the population by either increasing or decreasing its size. Some examples are fishing, pollution, water temperature, stream flow, predation, and competition. Since the magnitude of the population is known for only 7 years, no conclusions can be made as to causes for fluctuations in abundance. After population parameters have been determined for an additional number of years, hypotheses may be formulated to account for changes in abundance. If factors affecting these changes can be determined and controlled, the St. Johns River shad population can then be managed on an optimum sustained yield basis. However, if they cannot be controlled, their effect could probably be predicted and the fishery managed accordingly.

LITERATURE CITED

Cating, James P.
1953. Determining age of Atlantic shad from their scales. U. S. Fish and Wildlife Ser., Fish. Bull., 54(85):187-199.

Chapman, D. G.
1948. Problems in enumeration of populations of spawning sockeye salmon. 2. A mathematical study of confidence limits of salmon populations calculated from sample tag ratios. Internatl. Pacific Salmon Fish. Comm., Bull. 2:69-85.

Power, E. A.
1958. Fishery statistics of the United States, 1956. U. S. Fish and Wildlife Ser., Stat. Digest 43:1-476.

Ricker, W. E.
1940. Relation of "catch per unit effort" to abundance and rate of exploitation. Fish. Res. Bd. Can., Jour., 5(1):43-70.

Stevenson, C. H.
1899. The shad fisheries of the Atlantic Coast of the United States. U. S. Comm. of Fish and Fisheries, Rept. for 1898, Appendix: 101-269.

Talbot, Gerald B.
1954. Factors associated with fluctuations in abundance of Hudson River shad. U. S. Fish and Wildlife Ser., Fish. Bull., 56(101):373-413.

Talbot, Gerald B. and James E. Sykes
1958. Atlantic Coast migrations of American shad. U. S. Fish and Wildlife Ser., Fish. Bull., 58(142):473-490.

DISCUSSION

MR. FRANK [Connecticut]: I would like to know how long of an open season you allow for sports fishing of shad and how long you allow for nets.

MR. WALBURG: Well, I am not a resident of Florida. However, they have no closed season on the taking of shad by sport tackle. That was instigated three years ago. The commercial fishing season runs from November 15 until March 1, but may be extended for one to two weeks, at the discretion of the commissioners. The shad spawn in the St. John's River. The spawning run begins as early as November, but spawning actually doesn't begin until February and continues into April.

MR. FRANK: Is that fish basically the same in size and firmness of the flesh as it is up North?

MR. WALBURG: I would say so, until the water temperature gets rather warm and then, of course, it becomes soft. In February and March, when water temperatures are relatively cool, it is still the same caliber of fish that we catch up North.

MR. HANSEN [Oregon]: I would like to know if you have had any trouble in any of the commercial fisheries there with incidental catches. Out in the Goose Bay area of Oregon, we have the striped bass that intermingles with the shad at spawning time. As a result, there is a considerable catch of striped bass in connection with shad fishing there. Have you had this trouble?

MR. WALBURG: No. The only trouble we have had is with taking other game fish, such as the bream, which are supposed to be released when they are caught. However, some of these other fish which are of no value are merely thrown up on the bank. We have had no problem with the striped bass.

MANAGEMENT TECHNIQUES IN AN OFFSHORE FISHERY

LEE F. BRACKETT

U. S. Fish and Wildlife Service Bureau of Commercial Fisheries, Gloucester, Massachusetts

The haddock *(Melanogrammus aeglefinus)* stocks of the Northwest Atlantic, and particularly those of Georges Bank, which is located some one to two hundred miles off the Massachusetts coast, have been the object of rather intensive research for many years. By 1952 our scientists had learned enough about the life histories of these fish to conclude that a regulation prescribing a minimum mesh size would increase long-term production from the resource and that the approach was economically sound (Graham, 1952). Investigations indicated that the haddock of the Gulf of Maine—Georges Bank area, although not comprising a single stock, did exhibit growth and mortality rates sufficiently similar to permit management on a unit population basis. A rapid growth rate and a relatively low mortality rate pointed towards feasible management of these haddock stocks. Although other management tools were available, regulation of the mesh size used in the fishery appeared to be the most direct and feasible approach, the object being to permit the escape of small and unmarketable fish through the meshes of the net so that they may remain in the sea to grow.

Until the first mesh regulation was adopted in 1953, trawlers were using a mesh size averaging 2⅞ inches, which resulted in the killing and discarding of millions of pounds of small haddock at sea. (Herrington, 1935; Graham, 1952)

The first regulation, which was published on April 24, 1953 in Volume 18, page 2414 of the Federal Register, was applicable for six months and required the use of a 4½-inch mesh which size permitted the escapement of haddock below 37 cm., or fish less than 2½ years of age. It was forecast (Graham, 1952) that the adoption of the regulation would result in a 30% long-term increase in haddock landings, provided that recruitment remained at a comparable level. This regulation was applicable to the entire Northwest Atlantic area, and in addition to the minimum mesh-size requirement, it prohibited the possession of haddock in significant quantities on board a vessel together with nets having mesh sizes smaller than that prescribed for the haddock fishery. By the end of this period twenty prosecutions had been successfully terminated in the Federal District Court at Boston, but the regulation was then reviewed and amended. Because of a ruling from the Solicitor's Office, the amended regulation was made applicable only to the Georges Bank-Gulf of Maine area, and the provision relating to the possession of haddock together with small-mesh nets was removed.

The immediate result of this action was that several cases pending in court were immediately dismissed by the U. S. Attorney's office on the grounds that conviction would be impossible under the new regulation and that it would be unethical to proceed against these defendants under the provisions of a regulation that had been repealed.

An effort was then made to build a dockside prima facie case based upon the possession of haddock and small-mesh nets, but the fishermen soon learned to carry both the required mesh size and the smaller mesh. Questions of jurisdiction also arose, due to the comparatively small area to which the regulation was then applicable, and it became virtually impossible for the Government to prove that the fish had been caught within the regulatory area without actually witnessing the fishing operation at sea.

Due to the large water area with which we were even then involved, it was considered that every effort must be made to make dockside enforcement possible and to bring about maximum voluntary compliance by the fishing industry. The economics involved in the fishery virtually precluded any large and expensive offshore enforcement effort. For that reason an intensive effort was made to acquaint the industry with the program and to point out the advantages which would accrue through compliance with the mesh regulation. A mailing list of some six hundred names was compiled, and descriptive material was sent out in addition to extensive use of the press. Workshop type meetings were held in the more important New England ports to which all interested persons were invited. The three Commissioners representing the United States on the International Commission are provided with an Industry Advisory Committee which was frequently assembled in order to obtain industry's views on proposals and to acquaint it with progress being made. During this period, reliance was placed upon a meager amount of offshore patrol, combined with voluntary compliance, but the larger operators had by then learned that compliance was to their advantage and the majority made no attempt to revert to the smaller mesh which they had previously used.

In the spring of 1956, an attempt was made through regulatory amendment published on September 25 in Vol. 22, pages 7297-7299 of the Federal Register to legally identify haddock boats on the theory that restrictions might then be placed upon these vessels which would not be applicable to the fishing fleet in general, thus eliminating the legal objection to the original general provision relating to the

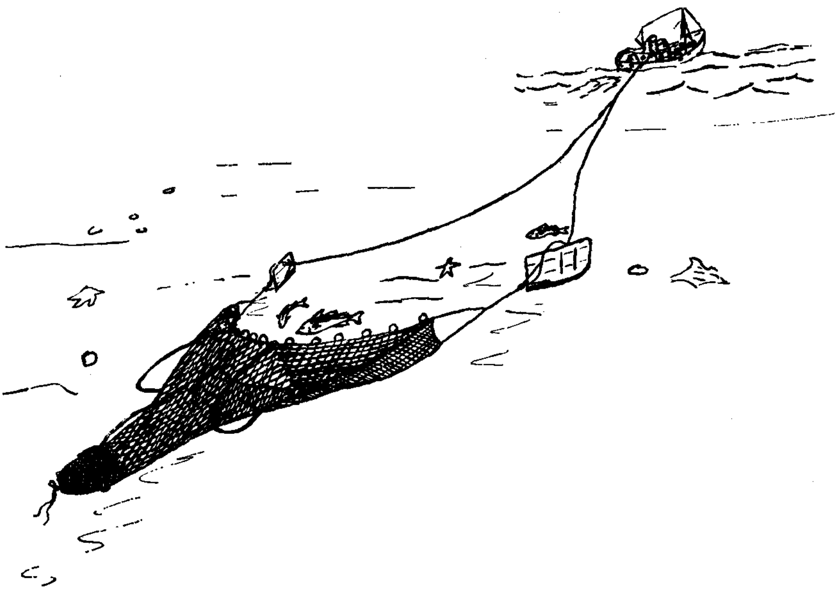

Figure 1. Otter trawl in action.

possession of small-mesh gear (Figure 1). As a result, haddock boats were required to obtain a haddock registration certificate from the Bureau and once so-registered, the possession or use of gear measuring less than 4½ inches was prohibited. This provision was helpful, but the necessity still remained to produce evidence that the fish had been taken within our area of jurisdiction. This was finally overcome to a great extent by extending the regulatory area as described on page 733 in Volume 24 of the Federal Register of February 3, 1959, to include all the banks where haddock are taken in commercial quantities and then proceeding on the basis of presumptive evidence.

Regardless of the apparent success of the inshore enforcement effort, there was still work to be done at sea in order to discourage those illegal practices which the fishermen are able to conceal at the dock. To accomplish this end with a minimum of added expense, we have entered into a boarding agreement with the United States Coast Guard. The primary mission of the Coast Guard in the New England area is search and rescue, much of which is in connection with the fishing fleet. Coast Guard boarding crews have been instructed in enforcement procedures by agents of the Bureau of Commercial Fisheries, and they are now making independent inspections of fishing gear at sea. As a result of each inspection, a boarding report is forwarded to us for whatever action circumstances indicate. Arrests and seizures by Coast Guard personnel on the high seas are not normally contemplated, nor are they, as a matter of fact, attempted by our own personnel except as a last resort.

The New England fishery has traditionally been a ''mixed'' fishery in that several species occur in the same area, even though one species may predominate. For that reason, it was immediately recognized when drafting the original mesh regulation that some recognition of this fact must be made in order to make the regulation realistic and, therefore, enforcible. Since the regulation was aimed at the conservation of haddock, it was necessary to find a means of applying it to haddock fishermen alone and not to fishermen who traditionally had taken other species primarily but who accidentally or otherwise had taken small quantities of haddock. A study of landing records indicated that the small and medium trawlers fishing primarily for species other than haddock rarely took more than 5000 pounds of haddock during a trip, while the large trawlers fishing for these other species seldom exceeded 10% of all fish on board. For these reasons all trawlers were exempted from the mesh requirements which in any trip took haddock in amounts less than 5000 pounds or 10% of all fish on board, whichever was larger. Experience gained during the first year of operation under the mesh regulation, however, indicated this exemption to be inadequate.

There are a rather large number of small and medium trawlers operating out of New England ports which are primarily engaged in catching redfish *(Sabestes marinus)* but which do catch haddock in substantial quantities during certain months of the year. Several of these vessels' operators were prosecuted for exceeding the exempted amounts of haddock while using the smaller mesh customarily used in taking redfish. These operators successfully complained to the courts that they were not primarily haddock fishermen, that the fish are dead when brought on board and to return them to the sea in order to comply with a regulatory requirement was neither economically desirable nor in the best interest of resource conservation. Again the landing records of these vessels were studied, and it was found that while haddock did at times constitute an important part of the catch, it did not, nevertheless, exceed 10% of the vessels' total landings during any 12-month period. An amendment to the regulation was, therefore, made providing that the operator of a vessel primarily engaged in a fishery other than the haddock fishery may make application for and receive a certificate of exemption which will then exempt the operation of his vessel from the necessity of compliance with the mesh regulation, provided that the vessel continues to land haddock in amounts less than 10% on an annual basis. The vessel operator so exempted is required to submit to the Bureau of Commercial Fisheries a certified statement of all fish landed by weight and species immediately upon the conclusion of each trip. This exemption, although authorized by the International Commission on an experimental basis only, is still in effect but will be reviewed by the Commission this year to determine whether or not the provision is adversely affecting management objectives.

A substantial increase in the individual weights of haddock landed has persisited since enactment of the mesh regulation which would substantiate earlier predictions of benefit. Discards at sea of small and unmarketable fish have virtually been eliminated, resulting in less labor and more efficient utilization of the resource. The effects of the regulation are under constant study and revised estimates of benefit are being made as more data on the fish actually caught under regulation become available.

LITERATURE CITED

Graham, H. W.
1954. Conserving New England haddock. Trans. 19th N. Am. Wildlife Conf.
1952. Mesh regulation to increase the yield of the Georges Bank haddock fishery. ICNAF Second Annual Report.
Herrington, W. C.
1935. Modifications in gear to curtail the destruction of undersized fish in otter trawling. Bureau of Fisheries, U. S. Dept. Commerce, Investigational Report No. 24, 48 pp.

PACIFIC SALMON IN INTERNATIONAL WATERS[1]

ALLAN C. HARTT
Fisheries Research Institute, College of Fisheries, University of Washington, Seattle

Intensive research of the past several years has shown that the five species of Pacific salmon (genus *Oncorhynchus*) and steelhead trout *(Salmo gairdnerii)* travel tremendous distances in their oceanic migrations. North American salmon travel so far west, and Asian salmon travel so far east, that stocks from both continents are found mixed throughout a large part of the central North Pacific Ocean and Bering Sea. King or chinook salmon *(O. tshawytscha)* hatched in the gravels of the Salmon River in the State of Idaho range at least 2,500 miles to the central Aleutian area before maturing and returning again to ascend the Columbia River. Red or sockeye salmon *(O. nerka)* from lakes in British Columbia swim westward at least to 177° East Longitude, well over halfway to Asia in their ocean travels. Chum salmon *(O. keta)* from southeastern Alaska may make the 3,500-mile round trip to the central Aleutians in their quest for food at sea. Steelhead trout from rivers of the State of Washington and Oregon also wander at least to the central Aleutians in their seaward journeys.

Likewise chum salmon and pink salmon *(O. gorbuscha)* from many Asian spawning areas are found along the Aleutian chain as far eastward as the Alaska Peninsula, 1,500 to 2,000 miles from their natal streams. Chums in the rich ocean feeding areas at the base of the Alaska Peninsula often are a mixture of stocks originating from such diverse spawning grounds as the Anadyr River in the Siberian Arctic, various rivers tributary to the Sea of Okhotsk, streams on the island of Hokkaido, Japan, and as already mentioned, streams in many parts of Alaska. Silver or coho salmon *(O. kisutch)* from East Kamchatka range seaward to the central Aleutians (175°W.), a distance of at least 1,000 miles.

These and other facts on the ocean life history of salmon are being brought to light by a large-scale research program under the auspices of the International North Pacific Fisheries Commission (Canada, Japan, and United States). The research is designed to provide information needed by the Commission to determine the oceanic distribution of North American and Asian salmon in order that measures may be taken within the framework of the North Pacific Treaty to protect the already hard-pressed United States and Canadian salmon stocks. The treaty signed in 1952 by the three countries set up a

[1]Contribution No. 78, College of Fisheries, University of Washington.

provisional line at 175° West Longitude, east of which, Japan agreed not to fish for salmon and some other species not pertinent to this discussion.

Research by the three nations attacks the problem on a wide front. Racial characteristics of all major Asian and North American stocks are being investigated for features which will distinguish Asian and North American salmon caught far at sea. Morphometric data, blood types, and identifying parasites have proved useful as distinguishing characters. Total distribution of salmon at sea and related oceanographic conditions are also being studied. A large part of the program has been tagging of salmon at sea, the results of which are the basis of this paper.

High seas salmon tagging has been conducted since 1955 by the Fisheries Research Institute of the College of Fisheries of the University of Washington under contract with the United States Bureau of Commercial Fisheries. Tagging is also being done by the Canadian and Japanese sections of the Commission, and the three programs integrated as far as practicable. The United States tagging experiments have been on a much larger scale than those of either Canada or Japan.

Tagging salmon on the high seas has proved much more difficult than tagging in coastal areas. Large, specially designed purse seines were developed for capturing salmon on the open sea in good condition for tagging. Brailing nets and holding tanks were designed for handling salmon with minimum injury. Experiments were needed to find tags that would give maximum returns after 1 or 2 years on rapidly growing fish. Identification of the several species of salmon, not normally a problem in coastal areas where fish are mature, was a problem at sea. Catches often included all five species and many age groups. Rapid identification of the younger fish sometimes only 8 to 10 inches long required experience. Scale samples were taken from all fish tagged for later positive identification.

A total of 48,296 salmon and steelhead have been tagged over the five years, and 1,128 have been returned to date. The overall rate of return (2.3 percent) is based on all salmon tagged, including immatures, which of course yield fewer returns than matures. Returns of mature salmon average nearly 10 percent. A "mature" salmon is one destined to spawn in the year of tagging. "Immatures" may spawn one, two, or three years later. Additional immatures still at liberty will be recovered in 1960 and 1961. Returns from central Pacific experiments have come from Japan, the U.S.S.R., Alaska, Canada, Washington, Oregon, and Idaho, as well as from the Japa-

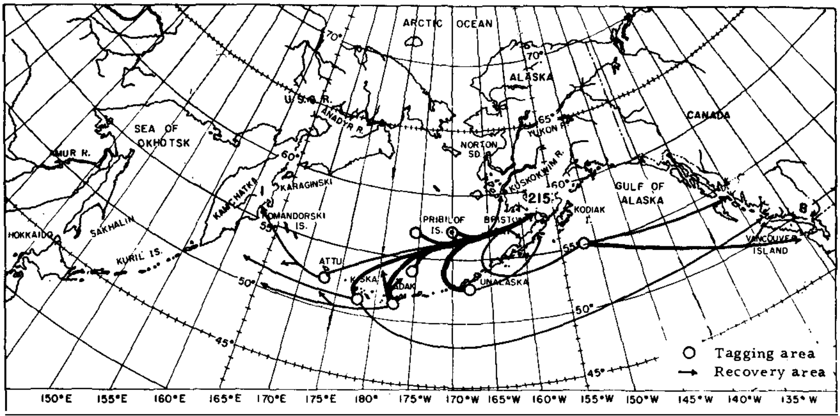

Figure 1. Generalized distribution pattern of tag returns from red salmon tagged at sea from 1956 to 1959.

nese high seas gill net fishery in the North Pacific Ocean and Bering Sea.

Each year, results of the tagging have disclosed new and valuable data on the ocean habits and movements of salmon. The abundance and migration patterns of the several species have been found to vary tremendously from year to year, so that continued observations are needed to fully answer the questions implicit in the North Pacific Treaty.

A summary of results to date for all species is presented in Figures 1, 2, 3, and 4. Tagging areas are shown by circles and recovery loca-

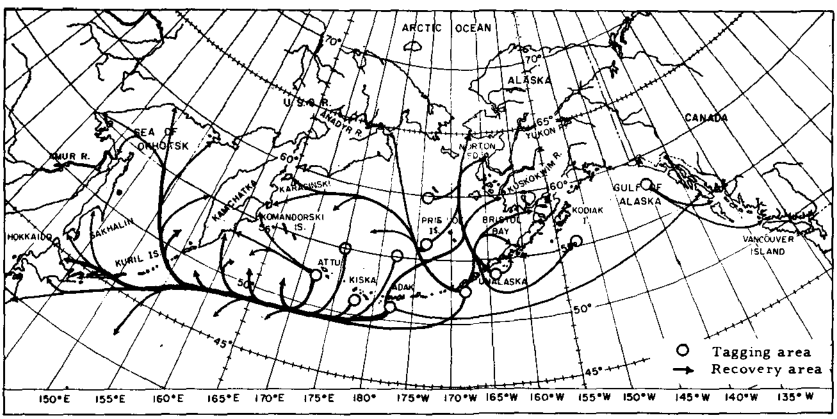

Figure 2. Generalized distribution pattern of tag returns from chum salmon tagged at sea from 1956 to 1959.

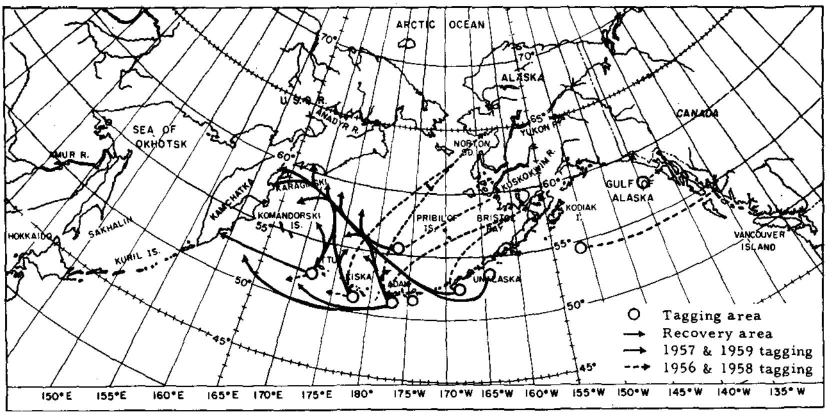

Figure 3. Generalized distribution pattern of tag returns from pink salmon tagged at sea from 1956 to 1959.

Aleutian Passes because purse seine catches indicated a positive westtions by arrowheads. The thickness of lines indicates approximate relative numbers of fish going to a given destination. Lines are not intended to show exact routes, and are drawn diagrammatically for simplicity. Fish are shown moving westward prior to going through ward movement through tagging areas south of the Aleutians. In evaluating the four figures, it must be borne in mind that most tagging was in the areas along the Aleutians from 160° West to 170° East Longitude. Both matures and immatures were tagged. Matures of course are recovered only in the year of tagging, while immatures

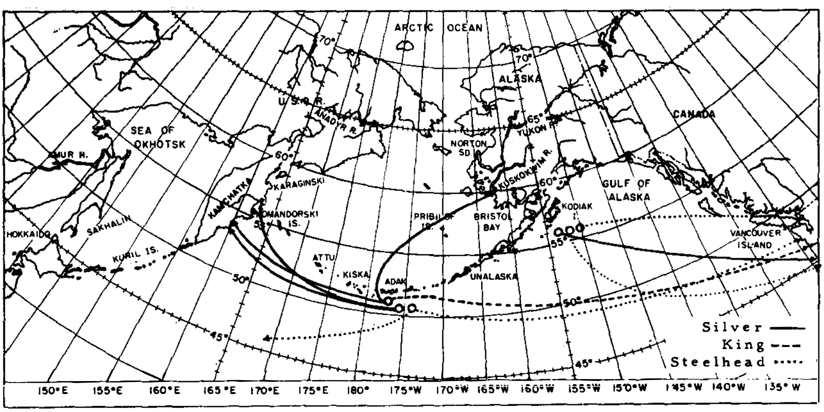

Figure 4. Generalized distribution pattern of tag returns from king and silver salmon and steelhead trout tagged at sea from 1956 to 1959.

are recovered 1 or 2 years later (except for a few immatures which were taken by the Japanese high seas gear in the year of tagging). Since tagging was conducted at numerous locations each year from May to September, returns may be considered representative of summer stocks in the Aleutian area.

Red salmon returns (Figure 1) indicate the overwhelming predominance of North American stocks along the entire Aleutian Chain in both the North Pacific and Bering Sea. A total of 215 were returned from Bristol Bay. Only one of this species was returned from Asia. A few others taken at intermediate points on the high seas may have been destined for Asia also. The distribution of returns is in keeping with the relative production in Asia and America; red salmon production in Bristol Bay alone is much greater than that of Asia.

Results further indicate that few reds in the Aleutian areas are from streams outside of Bristol Bay. As illustrated, one red tagged west of 160° West was returned from south of the Alaska Peninsula, and one from Canada. Only small numbers of reds have been tagged in the Gulf of Alaska, and these in 1958 and 1959. Returns were received from both Canada and Bristol Bay as shown in Figure 1. It is notable that of 7 reds tagged in a single haul, one went east to Canada and one west to Bristol Bay.

Chum salmon (Figure 2) show quite a different picture, with the great majority tagged in the Aleutians returning to Asian streams. The Aleutian experiments yielded 146 returns from Asia, and 52 from Alaska. Nearly all Alaskan returns were from releases in the eastern Aleutians. Again results are in harmony with relative production in the pertinent recovery areas; Asian chum salmon production is many times that of northwest Alaska. Alaskan chums are present at least to 177° West. The lone return to southeast Alaska indicates that few chums from this source travel as far as the central Aleutians.

Pink salmon returns (Figure 3) show a different picture than either red or chum salmon. It should be noted here that pink salmon have a very uniform two-year life history, and in many areas throughout their range, runs have a pronounced cyclic abundance in either odd or even years. In odd years (1957 and 1959), pinks were abundant in the Aleutian tagging areas, and tag returns came only from East Kamchatka or were intercepted at intermediate points on the high seas by the Japanese fleet. (In 1955, tagging consisted of small-scale preliminary experiments only as far west as Kodiak Island.) In even years (1956 and 1958), pinks were present in relatively small numbers, but all coastal returns were from Alaska. Those taken on the high seas, as shown, may have been destined for Asia. It is noteworthy that runs to East Kamchatka were large in 1957 and 1959, and small in 1956 and 1958. Although other Asian production areas (West Kamchatka, for example) have very large runs in both even and odd years, these areas have yielded no pink salmon returns to date. East Kamchatkan pink runs are many times larger than those to northwest Alaska, at least in odd years. The few pinks tagged in the Gulf of Alaska indicate that some of this species cross the Gulf from southeastern Alaska.

Results of king and silver salmon, and of steelhead trout tagging, as mentioned in the introduction, have demonstrated that these species travel spectacular distances at sea, but numbers tagged and recovered have been too small for conclusions as to relative importance of Asian and American stocks in the areas of intermingling. In Figure 4 each arrow indicates only one tag return. To date, returns of kings and steelhead have come only from America, but silvers have come from both continents. American production of kings and steelhead is far greater than Asian.

Thus, the tagging to date has shown a mixture of both American and Asian salmon in the ocean areas fished by the Japanese high seas fleet. Red salmon are overwhelmingly American (Bristol Bay) across the full length of the Aleutians. Chums are a mixture, with Asian fish probably predominating in areas west of 170° West Longitude. Pinks are abundant and overwhelmingly Asian in odd years, whereas in even years this species is scarce, but principally American in origin.

The problem of boundaries of distribution of Asian and American salmon is thus made more complex by the dissimilar distributions of the several species. These distributions can be expected to vary annually in accordance with relative abundance and perhaps according to varying migration patterns, oceanographic conditions, etc.

By some, the high seas fishery has been viewed as analagous to our harvesting of migratory waterfowl. Birds hatched and reared in one country or state are harvested there, and also in other countries or states through which they may migrate and in which they feed. The fishing of salmon on the high seas is actually quite different from the above, however, since the fish are being taken in international waters. If the salmon were harvested *within* the jurisdictional limits of national waters, then the analogy would be more appropriate.

Canadian and United States regulations require all salmon fishing, except some trolling, to be within territorial waters. This permits much more effective regulation since fishing intensity upon runs to individual rivers may be regulated according to size of runs. Depleted stocks may be protected and healthy runs fished more. High seas harvesting permits no such individual controls. In addition, at sea many immature salmon are harvested along with the matures, which is seldom the case in coastal fisheries.

Thus the advent of the Japanese high seas fishery in 1952 has introduced a new and peculiar problem to international fishery agreements. The species being fished are spawned and reared within continental river drainages and territorial waters, yet for one, two, or three years, they feed and grow in vast international areas of the North Pacific Ocean and the Bering Sea. An appropriate analogy might be that of cattle grazing on "open range," as practiced in some cattle-raising areas of our western states. By this system, cattle belonging to various ranchers are allowed to pasture and roam freely on large tracts of unfenced and unclaimed land. When "round up" time comes, however, each rancher sorts out and claims only those cattle bearing his individual "brand" plus any attendant offspring which may have been born. Here the analogy ends, however, since fish taken at sea bear no "brand" but are an *unmarked* mixture from widespread "ranches." There is one very important difference: salmon instinctively perform their own "round up" as fish belonging to individual "ranches" separate from the mixture and return to their home stream at maturity. Therefore, by fishing for salmon only in coastal areas and estuaries as is done in the United States and Canada (and incidentally in the U.S.S.R. also), catches consist only of prime mature salmon of known origin.

In summary, this paper is intended to present a brief outline of results to date of one phase of a large research program on Pacific salmon at sea, and of the particular problem which made the studies necessary. In addition to providing data for the purposes of the International North Pacific Fisheries Commission, the research is providing a wealth of information on the ocean biology of salmon, a field previously studied but little. The saltwater life-history of salmon and steelhead is proving no less remarkable than their much-studied yet little-understood freshwater life-history.

DISCUSSION

CHAIRMAN BARTHOLOMEW: Is the take of salmon on the high seas by the Japanese a significant quantity with regard to shore base fisheries?

MR. HARTT: Yes. The Japanese fisheries in some years take more red salmon than Asia and North America put together. Some years their total take of all species has been 80 million salmon.

MR. STEWART [Connecticut]: Do you have any data of the wanderings of the Atlantic salmon?

MR. HARTT: I know it has been investigated considerably but I am not sure about the total distance they have traveled. They wander long distances, and around Britain, I can recall diagrams where they go three-quarters of the way around the island and various points offshore. However, in connection with the Swedish fisheries, in the Norwegian areas, they have them pretty well controlled all the way through the Baltic and they know the growth sequence of the fish in connection with the various distances from the streams.

MR. STEWART: I know that they wander a great deal. However, it seems to be a mystery as to just where they wander. I was wondering whether there was any data on this.

MR. HARTT: Yes, in connection with Atlantic salmon, they have established that there are large stocks that spend their entire lives in the Baltic and others wander up and down the outer Norwegian coast. As to depth, it is doubtful if they are any different than our steelhead and salmon. They seem to be surface-feeding fish. In some rare cases, the king salmon are deeper than 100 feet but the Canadians have done quite a bit of experimenting with gill nets in the Gulf of Alaska and all species of salmon are within the upper 150 feet at most. Further, between 80 and 90 per cent of them are in the upper 30 or 40 feet. Of course, there may be some conditions where they may be deeper, but thus far this has not been discovered.

DR. LAGLER [Michigan]: I too would like to commend our fellow scientist on whose work Mr. Hartt has so ably reported. At least one of the groups of nationals involved can be described by the use of that saying "darn clever."

I wonder if any consideration has been given to the electronic or chemical orientation or reorientation of such fish stocks as we are concerned with here? I was wondering if it would be possible to arrest these fish at sea and reorient them somehow to go anywhere we want them to go in the future.

MR. HARTT: It is an interesting thing to think about. However, the fishermen claim that when we tag a fish and mix it all up, that it may not return to his home stream. However, beyond that, it would be rather confusing, I think, if we could develop such a thing.

DR. LAGLER: Of course, we must admit the possibility that the treatment that we accord these fish in our tagging, and so forth, may cause them to flee our waters and so we may have an artifact in this beautiful picture.

TECHNICAL SESSIONS

Wednesday Morning—March 9

Chairman: WILLIAM L. WEBB
Associate Professor, State University College of Forestry, Syracuse, New York

Discussion Leader: LOWELL ADAMS
Wildlife Research Biologist, U. S. Forest Service, Susanville Research Center, Susanville, California

---

FOREST AND RANGE RESOURCES

TRAPPING, IMMOBILIZING AND COLOR-MARKING GRIZZLY BEARS

JOHN J. CRAIGHEAD
U. S. Fish and Wildlife Service, Missoula, Montana

MAURICE HORNOCKER
Montana State University, Missoula, Montana

WESLEY WOODGERD
Montana State Fish and Game Department, Missoula, Montana

FRANK C. CRAIGHEAD, JR.
National Geographic Society, Washington, D. C.

This investigation was initiated by the Montana Cooperative Wildlife Research Unit[1] to gather information on population dynamics, behavior, and other data concerning the grizzly bear, *Ursus horribilis.*

A number of bear studies have been conducted in recent years. The investigators have encountered common problems in trapping and handling these large mammals; the details varying with the kind of study area and the species of bear involved. Our experiences

[1]Contribution from the Montana Cooperative Wildlife Research Unit; U. S. Fish and Wildlife Service, Montana State Fish and Game Department, Montana State University, and Wildlife Management Institute cooperating.

in adapting live-trapping and immobilizing techniques and developing color-marking methods for grizzly bears in Yellowstone National Park constitute the subject matter of this progress report. We hope it will prove helpful to others pursuing similar lines of investigation. A grizzly bear population has not until now been the subject of intensive trapping and marking. Therefore a brief discussion of the general status of this large carnivore in the United States and in Yellowstone in particular seems desirable.

Since Lewis and Clark first saw grizzly bears on our western prairies in 1805, their numbers have steadily declined. In the United States (with the exception of Alaska) they now exist only as remnant populations in wilderness areas, national parks, and national forests of the Rocky Mountains.

The grizzly, an endangered species, has disappeared from Texas, Kansas, Arizona, New Mexico, Oregon, Utah, and the Dakotas. In California, where it was once numerous, there has been no record of a grizzly for 38 years (Storer, 1955). Cooney (1956) reviewed the status of the grizzly in the United States and concluded that the State of Washington may have a few, Colorado possibly 10, Idaho approximately 60, and Wyoming, excluding Yellowstone National Park, not more than 50. Montana lists about 450 exclusive of Glacier National Park. Estimates for Glacier and Yellowstone at that time showed 100 and 125 grizzlies respectively. Rough estimates indicate the number of grizzlies left in the United States, excluding Alaska, may lie between 500 and 1,000. Thus there is need for detailed ecological studies of the grizzly throughout its present range if it is to be preserved and intelligently managed. This has been recognized for some time, but formidable obstacles have prevented intensive research.

Obstacles to such a study in western United States have been:

1. Solving the tremendous physical problem of gathering data and supplying an operation over thousands of square miles of wilderness grizzly habitat.
2. Locating a grizzly bear population sufficiently large and localized that any considerable quantitative data could be obtained.
3. Adapting and improving methods of immobilizing wild bears for detailed inspection and measurement.
4. Developing a method or methods of marking grizzlies so individuals and known-age animals could be observed in the field.

After much fruitless searching in Montana for a suitable study site, Yellowstone National Park was investigated and found to have a wild grizzly population sufficiently free of artificiality that fundamental biological data could be obtained and on a quantitative basis.

Advantages of the Yellowstone area are that grizzlies are numerous, readily observable, and can be studied both in the vicinity of man and in the back country—a situation that should yield basic ecological data as well as information on the adaptation of this large carnivore to man. The National Park Service indicated interest in a proposal for research and offered to cooperate in the study. Park records and literature dealing with the fauna of Yellowstone provide a wealth of general information on the grizzly and its history in the Park.

Skinner (1925) notes that as early as 1889 black bears, *Ursus americanus,* in Yellowstone began to frequent garbage piles, but it was not until three or four years later that grizzlies followed their example. On August 2, 1916, he had 29 grizzlies in sight—the most he had ever seen at one time. At about this time he estimated a total of 40 grizzlies in Yellowstone. His descriptions of the grizzlies in those early days indicate the relations of these bears to man and to artificial food in the park have changed little if any in the past 50 to 60 years. Regarding this he says, "Three-fourths of the bears we ordinarily see in the park are near scrap piles, yet it is evident that this is not their principal food, or even any considerable part."

In 60 years of close association with man, the grizzlies in Yellowstone have not basically changed their behavior nor their habits. They have not become "roadside bums" like the black bear. From June through September they frequent the half dozen large garbage dumps chiefly during evening and night. Early in the season the bears are wary and come to the dumps only at night. Soon they get bolder and some begin arriving in the afternoon. This habit of concentrating where food is available has been characteristic of the grizzly from the time his numbers and behavior were first recorded and there are innumerable references to this in the literature. Storer and Trevis (1955) in citing early writers, quote such phrases as . . . "regiment of bears," . . . "countless troops," . . . "bears are very plentiful," . . . "are often seen in herds," . . . "not unusual to see fifty or sixty within twenty-four hours" . . . "the whole lake and swamp seemed alive with bears.' ' These and numerous similar expressions referred to the California grizzly.

"Many early accounts tell of the grazing habits of grizzlies. The bears congregated locally to forage in wild pastures and made seasonal migrations to such places." (Storer and Trevis, op. cit.). The same authors summed up the gregarious behavior of the California grizzly in these words, "But when grizzlies congregated with their kind to relish some desirable food—clover, acorns, or whale—they ate together peaceably."

Food disposal areas attract bears in Yellowstone, just as the salmon streams of Alaska concentrate the Alaskan brown bear, *Ursus middendorfii* during the spawning runs. While feeding at these areas some bears are indifferent to man, but most are alert and sufficiently shy to run at the least disturbance. Skinner (1925) states, "Out in the wilderness that covers so much of the Yellowstone National Park, they (grizzlies) are just as wild, just as cautious, and just as difficult to find as bears anywhere else." This statement is essentially true today.

It seems the grizzlies' habit of concentrating where food is abundant and of seeking it boldly in the vicinity of man is not of modern origin.

With regard to their food, Skinner (op. cit.) says of grizzlies in Yellowstone . . . "grass is eaten as much, if not more, than any other single item, and this is true of the lordly grizzly as well as of the common bear . . . bears do not depend upon garbage."

Murie (1943 unpublished) studied the food habits of Yellowstone grizzlies and black bears and concluded that vegetation comprises 81 per cent of their food and garbage 6 per cent. He stated, "It was found too, that even at the camp grounds, where bears habitually sought garbage, natural food still constituted 89 per cent, garbage 10 per cent." Our examinations of grizzly bear feces at disposal areas during the summer of 1959 indicated heavy use of natural foods. The situation in Yellowstone where grizzlies concentrate to feed on garbage is not as artificial a condition as first appears.

It is the grizzlies' nature to scavenge and to congregate wherever food is available and we believe these natural traits of the grizzly are intensified under the conditions prevailing in Yellowstone. We seriously doubt if this will invalidate the basic data we plan to obtain; in fact, the behavior of grizzlies in Yellowstone is so reminiscent of the early accounts of the California grizzly as they came in contact with the settlers (Storer and Trevis, 1955) that we suspect "historic" bear and man relationships have been preserved rather than altered in Yellowstone National Park.

TRAPPING

Techniques for capturing and handling black bears were developed by Erickson (1957). This work stimulated black bear investigations in New York, Pennsylvania, West Virginia, Virginia, and Montana. It was inevitable that the basic techniques used should be applied to the grizzly bear. We captured grizzlies in culvert traps on trailer frames similar to those used by the U. S. National Park Service for capturing and moving nuisance bears. The basic design with modifi-

TABLE 1. IMMOBILIZING GRIZZLIES WITH SUCCINYLCHOLINE CHLORIDE

Bear No.	Weight (pounds)	Sex	Milligrams drug		Number of injections	Pounds of body weight per milligram of drug		Minutes required to take effect initial dose	Minutes immobilized		Minutes until complete recovery	
			Initial dose	Total all doses		Initial dose	Total all doses		Initial dose	All doses	Initial dose	All doses
1[1]	200	M	50	120	2	4.0	1.7	0.2	11	36	15	108
2	300	M	90	210	3	3.3	1.4	3.5	7	41	10	90
3	150	F	70		1	2.1		3.0	31		70	
4	240	M	70	120	2	3.4	2.0	5.0	7	31		42
5[1]	110	F	40	80	2	2.8	1.4	5.0	12	32	15	50
6	45	F	7	17	2	6.4	2.6	6.0		14		19
7	300	F	140		1	2.1		1.0	20		180	
8[1]	260	F	90		1	2.9		1.0	18		50	
9[1]	160	F	56		1	2.9		3.0	19		45	
10[1]	140	F	46		1	3.0		3.0	16		27	
11	120	F	34	212	5	3.5	0.6	3.5		12		35
12[1]	620	M	207		1	3.0		8.0	23		41	
13	645	M	215		1	3.0		4.0	Died			
14	520	M	150		1	3.5		1.0	6		7	
15[1]	150	F	50		1	3.0		4.0	16		25	
16[1]	300	F	100		1	3.0		4.0	18		27	
17[1]	435	F	145		1	3.0		5.0	15		25	
18[1]	380	F	127		1	3.0		3.0	19		41	
19[1]	235	M	78		1	3.0		2.0	17		23	
20[1]	280	M	100		1	2.8		4.0	17		34	
21	300	F	90	300	3	3.3	1.0			38		180
22[1]	260	M	86		1	3.0		6.0	12		25	
22[1]			85		1	3.0		3.5	21		41	
23	370	F	100		1	3.7		3.5	40		60	
23			80		1	4.6		2.0	Died			
24	70	M	14	34	2	5.0	2.1	2.0	Died			
25	50	?	12		1	4.0		3.0	4		4	
25[1]			15		1	3.3		2.5	20		30	
26[1]	90	M	20		1	4.5		5.0	10		17	
27[1]	505	M	150		1	3.4		3.0	24		40	
28[1]	500	M	125		1	4.0		3.0	16		25	
29	92	F	20	30	2	4.6	3.1	7.0		10		10
29			25	42	4	3.7	2.2	2.0		5		25
30	710	M	170		1	4.2		8.0	23		93	

[1]Satisfactory immobilizations—data analyzed in Tables 2, 3, and 4.

cations as well as the trapping techniques have been described by Erickson (1957) and Black (1958).

Counts made throughout the summer of 1959 indicated a minimum population of 150 grizzlies for Yellowstone National Park. Most of these bears concentrated in the disposal areas at night, but daily moved considerable distances. Thus sets were made at these feeding areas, along the back roads, and outside camp grounds. Fourteen grizzlies were captured in two traps during 21 nights of trapping. This constituted a trapping success of 76 per cent or 1 bear for every 1.3 trap nights. Black (1958) captured one black bear for every 3 culvert trap nights in 1956, less in 1957. Troyer (1960) informed us that he was unable to trap the Alaskan brown bear in culvert traps but was successful in capturing 32 in steel traps in 813 trap nights. Information on trapping success is lacking for 9 grizzlies trapped by park rangers which we marked and released. However, the sex, age, and weight of all trapped bears appear in Table 1. The bears range from yearlings to a 710-pound boar. Lactating sows were taken but no cubs were captured in culvert traps.

IMMOBILIZING AND HANDLING TRAPPED GRIZZLIES

All bears handled, whether trapped or shot free-roaming were immobilized by propulsive injection of succinylcholine chloride (Sucostrin) using a syringe dart and gas (CO_2) operated rifle. The automatic projectile type syringe and rifle are described by Crockford et al. (1958).

Erickson (1957) produced effective anaesthesia in black bear using one grain of Pentobarbital Sodium for each 5 pounds of body weight. Complete sedation was achieved in approximately 11 minutes. Black (1958) used 60 milligrams of Pentobarbital Sodium per 5½ pounds of body weight to produce anaesthesia. He also accomplished complete relaxation with intramuscular injection of succinylcholine chloride with doses averaging approximately 1 milligram for every 3.7 pounds of body weight.

During the summer of 1959 this rapid muscle relaxant was used successfully on black bear in Montana by Jonkel and Hawley (1960), on the Alaskan brown bear by Troyer (1960) on Kodiak Island, and by the authors on grizzly bear in Yellowstone.

After capturing a grizzly, we pulled bear and trailer onto portable scales and recorded the weight of trap, trailer, and bear. This was generally repeated three times or until constant weights (within 10 pounds) were recorded. The weight of the bear was then obtained by subtracting the known weight of trap and trailer from the recorded weight. Cubs were weighed on spring scales.

Dosages of Sucostrin were prepared on a basis of body weight. On large bears, crude adjustments in dosages were made to allow for estimated body fats. The grizzly was then maneuvered into position with a probe and shot in the side of the neck with a syringe dart. Intramuscular injection was intended, but in a few cases the dart may have penetrated a blood vessel.

After the bear collapsed, probing of the jaw indicated the degree of immobilization. Normally the jaws relaxed first followed by the forearms and finally the hind legs. The intercostal muscles and the diaphragm are last affected; respiration becomes depressed but with proper dosage breathing is quiet and regular. Normally, first symptoms were a fluttering of the eyelids. As the drug took effect the bear's head would lower until the muzzle rested on the chest; then the bear might sit on its haunches or roll directly to its side. With proper dosage, complete relaxation would occur within minutes. At first the door of the trap was raised with trepidation but as we gained confidence in the drug the procedure of hauling a large grizzly out of the culvert became routine.

Ear tags were placed on the upper leading edge of each ear as close to the base of the ear as possible. It was necessary to slit the tough hide in order to insert the tag. Color markers were put in the lower edge of both ears; a tattoo was placed under the forearm where the hair is thin and measurements and other data recorded. All bears were kept under observation until sufficiently recovered to move off. Of the grizzlies immobilized, some evidenced definite aggressive behavior when muscular control returned, others were aggressive only when pressed by the observers, and the majority were relatively submissive.

IMMOBILIZING AND HANDLING FREE-ROAMING GRIZZLIES

To shoot a free-roaming grizzly it was necessary to approach within 50 feet as the dart gun was unreliable at greater distances. Of seven bears obtained in this manner, five were shot from a vehicle and two (a yearling and a cub) were shot by stalking in the open.

The general procedure was to estimate the bear's weight and prepare 3 darts with dosages of succinylcholine chloride ranging above and below the indicated dosage. The bear was then approached as closely as possible and shot in the neck. The supplemental darts were used if the initial dose was unsatisfactory.

Each bear shot in this manner presented a different situation and little in the way of standardized procedure evolved. A 370-pound sow with two cubs wheeled and fled when the dart struck her. She collapsed in a stream and had to be hauled out while still not completely immobilized.

Cubs were captured at night by shooting them at the sides of their mothers. A flashlight was used to spot the cubs, and the marksman was covered with a rifle. Behavior of the sows varied widely but in no case did one charge. All but one deserted their downed cubs when the car motor was raced or a rifle discharged. One sow, however, returned before we could get to the cub, and she did not leave until the cub could walk away. Captured cubs were held overnight in a holding cage and released the next day after being immobilized a second time for tagging and marking.

EVALUATION OF SUCCINYLCHOLINE CHLORIDE

Succinylcholine chloride is not an anaesthetic but a short-acting skeletal muscle relaxant that blocks nervous transmission at the myoneural junction. It is sold under various trade names (Sucostrin, Anectine) and chemically is diacetylcholine. It replaces acetylcholine (the chemical compound that activates skeletal muscles) and blocks nervous transmission at the myoneural junction. Muscular paralysis persists until the diacetylcholine is hydrolyzed by cholinesterase in the blood and normal nerve transmission at the myoneural junction is again resumed. The amount of cholinesterase varies widely in blood and different organs of different species (Grollman and Slaughter, 1947). This probably accounts for its selective action on certain parts of the body.

The muscles of the eyelids are first to be affected when succinylcholine chloride is given to conscious human patients. Thereafter the muscles of the jaws, arms, legs, and abdomen are affected in the order given. Paralysis of the upper intercostal muscles then occurs and respiration becomes depressed. The diaphragm is last to be affected.

Intramuscular injections of high potency solutions were used to produce complete relaxation. Ten minutes were sufficient to allow the animal to be removed from the trap, tattooed, measured, ear tagged, and color marked for future individual recognition. Whenever a drug is administered intramuscularly it is difficult to control its absorption. This difficulty probably accounted for some unexpected reactions to the drug but individual susceptibility as well as other factors undoubtedly were also important. Literature supplied with the drug stated "The optimum intravenous dose for such purposes (short duration) will vary among individuals, usually ranging from 10 to 40 milligrams." A similar variation may be expected among individual grizzlies.

We experimented with dosages of succinylcholine chloride on the first half dozen grizzlies captured and arrived at a working dosage of approximately 1 milligram of Sucostrin per 3 pounds of body weight administered in a single dose. This rule-of-thumb dosage was used on all bears with modifications discussed later. No attempt was made to cage a grizzly and determine minimum, average, and lethal doses as it appeared there was considerable individual susceptibility to the drug as well as the probability that susceptibility might be altered by confinement.

Multiple Doses

There is need for more precise information on dosages to avoid mortality and reduce stress in treated animals, as well as to increase the safety of the bear handlers. With this in mind we have analyzed our data and experiences during a summer's work and present our findings for the benefit of other workers, recognizing that our conclusions are tentative.

Multiple doses were administered at first in an attempt to arrive at an effective single dose injection and whenever a bear failed to immobilize completely. A bear was considered immobilized only during the time it was prostrate and unable to bite. This served as a criterion for computing time interval immobilized (Tables 1 and 2). Recovery time (Tables 1 and 3) was considered to include time interval immobilized plus the time required to regain sufficient muscular control to leave the area. Ten of 30 bears or 30 percent required multiple doses. The average initial dose was 1 milligram of Sucostrin per 3.6 pounds of body weight with an average second dose of 1:4.5. The maximum initial dose that failed to achieve immobilization was 1 milligram per 3.3 pounds of body weight; the minimum 1:6.4.

Since succinylcholine chloride is hydrolized by cholinesterase, the time interval between injections is important in determining second or additional doses. Our experience and data are as yet too limited to suggest desirable multiple doses in terms of milligrams of drug per

TABLE 2. RELATION OF DOSAGE TO BEAR WEIGHT AND IMMOBILIZATION TIME (SINGLE DOSE SELECTED DATA FROM TABLE 1)

Time immobilized (minutes)	10–15	16–20	21–25
Average dose (pounds of body weight per milligram)	3.5	3.1	3.1
Average bear weight (pounds)	219	246	462
Number of bears	5	10	3

TABLE 3. RELATION OF DOSAGE TO BEAR WEIGHT AND RECOVERY TIME (SINGLE DOSE SELECTED DATA FROM TABLE 1)

Recovery time (minutes)	15–24	25–39	40–60
Average dose (pounds of body weight per milligram)	3.6	3.1	3.0
Average bear weight (pounds)	159	264	364
Number of bears	4	8	6

pounds of body weight, but we can offer some helpful observations.

Forty per cent of the animals requiring multiple doses were not immobilized with an initial dose. These bears upon receiving a second dose were either still not immobilized or if so, only for a brief period of time. On the other hand all bears immobilized to some extent with an initial dose were subsequently satisfactorily kept in that state or re-immobilized by a second dose.

Thus, indicated procedure for administering multiple doses is:

1. Where immobilization occurs with the initial dose but is of brief duration, administer a light second dose as soon as there are signs of returning muscle coordination.

2. Where immobilization does not occur with the initial dose, wait a minimum of 45 minutes, preferably longer, then administer a more potent second dose.

Whenever the initial dose failed and additional doses were given without a considerable time lapse, the recovery time was greatly prolonged. A heavy second dose (equal or greater than the initial dose) administered prematurely can be lethal.

The procedure recommended for administering multiple doses is far from perfected and exceptions are to be expected. The complexity of administering multiple doses to either trapped or free-roaming bears is illustrated by the following examples.

Bear 11, Table 1, received five injections within a period of approximately three hours. The initial dose was 34 milligrams or 1 milligram per 3.5 pounds of body weight and did not immobilize; seven minutes later 25 milligrams were administered with no apparent effect. About two hours later a 42 milligram injection failed to immobilize. This was followed 24 minutes later with a 50 milligram injection which caused partial paralysis but failed to immobilize. A final dose of 60 milligrams, 39 minutes after last injection, caused immobilization in three minutes. The total dose received was 211 milligrams or 1 milligram per 0.6 pounds of body weight.

A cub and litter mate to Bear 29 (Table 1) was estimated to weigh between 100 and 120 pounds. On two successive nights this cub was shot a total of five times in attempts to immobilize it. The first night, while feeding at its mother's side, the cub received an initial dose of 25 milligrams in the neck at a distance of 30 feet. It staggered but did not fall. A second dose of 15 milligrams similarly delivered, 15 minutes later, had no noticeable effect as did also a third dose of 20 milligrams approximately 10 minutes later. The second night, dosages of 33 and 22 milligrams were injected in the neck from approximately 30 feet. The first dose caused the cub to arch its neck and lie down momentarily; the second dose had no apparent effect. The sow became aroused and dangerous, and no further attempts were made to capture her cub.

Single Doses

Single dose injections proved more satisfactory than multiple doses. However, not all single dose injections were satisfactory nor successful (Table 1). The basis for computing a dosage was body weight, but it early became evident that other factors, such as age, sex, physical condition, injection site, amount of body fat and perhaps the age of the drug itself, might be affecting the drug action. An analysis of this type data showed no correlation between sex and drug action or between age of drug and its action. The succinylcholine chloride was kept under refrigeration to prevent deterioration, and none was opened and used for longer than 23 days. Comparison of the action of fresh solution and dosages prepared from bottles carried about and used for as long as 19 and 23 days showed no evidence of loss of potency with age.

Selected data from 17 bears (18 dosages) in which satisfactory immobilization occurred are presented in Table 2. An immobilization was considered satisfactory and selected for presentation in Table 2 if the time immobilized lay between 10 and 25 minutes and the recovery time one hour or less.

We can infer from the data of Tables 2 and 3 that an average dose of 1 milligram of Sucostrin per 3.5 to 3.6 pounds of body weight gave minimum immobilization and recovery times. An average dose of 1 to 3.1 yielded optimum results on medium-sized bears ranging in average weight between 246 and 264 pounds but resulted in prolonged immobilization and recovery in the larger bears (average weight 462 and 364).

If we consider an average immobilization time of 16 to 20 minutes and recovery time of 25 to 39 minutes to be optimum (Tables 2 and 3), then in general we tended to underdose small bears, administered optimum doses to medium-sized bears and overdosed the large bears. Data show that the larger bears were probably more sensitive to succinylcholine chloride than medium-sized bears.

There is a basic correlation between dosage and body weight of bears that appears to be modified by other factors. Age and amount of body fat were suspected as being important. We do not yet have sufficient data to determine the degree of susceptibility of cubs and other young bears. However, if we can consider weight as a function of age (Tables 2 and 3) then the inference is that older bears require less drug per pound of body weight to immobilize them satisfactorily than young bears. This is further supported by data on multiple doses. The average weight of all bears requiring 2 or more doses was 170 pounds and those failing to immobilize with the initial dose averaged 139 pounds.

We had no way of accurately estimating amount of body fat, but it was evident from field observation that the bear population in general did not begin to put on fat rapidly until about the first of August. By grouping data on 18 bears (receiving what we considered optimum drug doses) by time of year (Table 4) we find that bears immobilized between June 29 and July 31 required 1 milligram per 3.0 pounds of body weight whereas bears immobilized between August 1 and August 28 required an average dose of 1:3.4. It appears that the smaller average doses required late in the season were due to the fact that body fat was included as weight in dosage determination. Erickson (1957) found in using Halatal that "estimates of body fats should not be included as weight in dosage determination." We tentatively concur with this statement in regard to succinylcholine chloride.

TABLE 4. RELATION OF DOSAGE TO TIME OF YEAR

Time Period	6/29–7/31		8/4–8/28	
	Total	Average	Total	Average
Milligrams of drug administered	989	90	581	83
Number of bears	11		7	
Bear weight	2,990	272	1,945	278
Minutes immobilized	184	16.7	120	17.1
Minutes to recovery	334	30.4	212	30.3
Dosage pounds of body weight per milligram		3.0		3.4

In summarizing our data on single dose injection we recommend the following rule-of-thumb procedure until more information is available: For all grizzlies under 360 pounds administer 1 milligram of Sucostrin per 3 pounds of body weight. The fat weight should be subtracted from the total weight to give the weight for dosage determination. Except in the case of retrapped bears, fat weight will have to be an estimate. In time, data on fat accumulation during the summer months will be obtained and this information should lead to more accurate estimates. For bears over 360 pounds administer somewhere between 1:3 and 1:4 compensating for body fat. Very old bears may be quite susceptible and the dose should be conservative.[1]

MORTALITIES

Three mortalities occurred, and though this is regrettable the information obtained proved highly valuable. Bear No. 13 (Table 1) was immobilized in four minutes and died within 7 minutes from a dosage of 1:3.0. The bear was very old and fat and considering age

[1]Data accumulated in 1960 indicate that drug potency may vary. It is recommended that test doses of 1 mg. of Sucostrin per 5-6 lbs. body weight be used before attempting heavier doses.

and physical condition, we believe death resulted from an overdose.

Bear No. 23, a lactating female, evidenced prolonged immobilization and recovery from a dosage of 1:3.7. Breathing became depressed and artificial respiration was administered after which breathing improved and the bear recovered completely but slowly. This bear was held in the trap for 36 hours in an attempt to trap her cubs. She was then administered a dose of 1:4.6, became immobilized in 2 minutes, was color marked, ear tagged, and was regaining muscular control when she relapsed and stopped breathing. Fifteen minutes of artificial respiration failed to revive her. All or any of the above factors may have contributed to her death. However, we suspect death resulted directly from cardiac fibrillation caused by adrenalin release due to excitement, and hypercapnia resulting from poor pulmonary ventilation.

Bear No. 24, a 70-pound cub, was shot free-roaming with a dose of 1:5.0. He went down but regained muscular control rapidly. The sow was alerted and nearby. A second dose of 1:3.5 was administered with a syringe. We believe this second dose was too heavy considering the bear had been immobilized by the first injection. It is possible that the second injection was intravenous since it caused paralysis in one minute. The total dosage was 1:2.1 and proved lethal in spite of artificial respiration. Cause of death appeared to be similar to bear No. 23. Use of a resusitator with tracheal catheter should help eliminate fatalities in the future. Our operations probably saved some grizzlies that ordinarily would have been disposed of as dangerous. This was accomplished by immobilizing and removing them from contact with tourists. The use of immobilizing techniques in the future will no doubt save grizzlies in the park each year.

COLOR MARKING

Color marking permits field recognition and observation of individuals and age classes. To be useful markers should be both visible and durable; the ideal marker would last the lifetime of the animal marked. We were doubtful that grizzlies with their predisposition to fight and chew one another would long retain conventional color markers. We therefore proceeded on the theory that a number of markers had a better chance of retention than only one. Accordingly we slit the lower leading edge of each ear and inserted plasticized polyvinyl chloride tape (Craighead and Stockstad, submitted for publication). In addition, the tough hide on the back of the neck was punctured and tape threaded through and secured with rivets. Eight basic colors were used and this gave 64 combinations for individual identification when identical markers were used for each ear of every individual marked. Each marker consisted of an ear loop and a tail of different color. Both ends of the ear loop close over the tail strip and are secured with brass rivets. The neck marker was experimental and used to designate original site of capture.

Visibility of markers was excellent in daylight and good at close range at night with flashlights. Reflective tape can be attached over the basic color combinations for nocturnal observation.

Of 27 grizzlies color marked and released, 13 were observed and identified. One was sighted 27 times, the average being 12 observations per bear. Fourteen other marked bears were not seen but most of these were marked and released with no attempt made to obtain sight records.

Retention of the markers surpassed our expectations. Prior to hibernation one bear had lost its neck marker and the tail of the left ear marker but the right ear marker was still intact. Two other bears lost an ear marker or part of one.

A small male, shot outside the park boundaries in October, still had both ear markers and neck marker in excellent condition 84 days after marking. We believe most of the marked bears went into hibernation with their color markers intact. Elk marked in a similar manner with vinyl tape (Craighead and Stockstad, op. cit.) still had color markers when shot 20 and 21 months later.

The value of color marking grizzlies is evident. During the summer we obtained 160 specific observations yielding information on range, population composition, and behavior. During the same period of time only two grizzlies were retrapped.

ACKNOWLEDGMENTS

Financial support from the Wildlife Management Institute and the National Geographic Society was instrumental in getting this project started. Appreciation is extended to the National Park Service for giving us freedom to conduct research and for helping and cooperating in many ways. We are particularly grateful to Lemuel Garrison, Superintendent of Yellowstone, and Gordon Fredine, Chief Biologist, National Park Service, for their encouragement of our efforts. Thanks are also due to park rangers Bob Howe, Art Hayes, Lloyd Honer, Harry Reynolds, Elton Davis; and park naturalists Dave Condon, Pat McIntyre, and Merrill Beal, and all other National Park personnel who gave us a helping hand.

SUMMARY

An intensive long-term study of the grizzly bear, *Ursus horribilis,* was initiated in Yellowstone National Park during the summer of 1959.

Thirty grizzlies were captured and 27 ear tagged, color marked, and released for future observation. Twenty-three bears were captured in mobile culvert traps and 7 were shot free-roaming with propulsive syringe darts using a gas-operated rifle. All bears handled, whether trapped or shot free-roaming, were immobilized by propulsive injection of succinylcholine chloride, a rapid muscle relaxant. Of the grizzlies immobilized, some evidenced definite aggressive behavior when muscular control returned, others were aggressive only when pressed, and the majority were relatively submissive.

Cubs were captured at night by "shooting" them at the sides of their mothers. Behavior of the sows varied but in no case did one charge.

Both multiple and single dose injections of succinylcholine chloride were administered. Thirty percent of the grizzlies treated required multiple doses; the average initial dose being 1 milligram of drug pr 3.6 pounds of body weight with an average second dose of 1:4.5.

Single dose injections proved more satisfactory than multiple doses. A satisfactory dose immobilized a grizzly for 10 to 25 minutes with complete recovery time of one hour or less. There was a basic correlation between dosage and body weight of bears that appeared to be modified by such factors as age, amount of body fat and injection site. In general, single doses of 1 milligram of drug 3.5 pounds of body weight gave minimum immobilization and recovery time. Doses of 1 milligram of drug to 3 pounds of body weight yielded optimum results on medium-sized bears, but resulted in prolonged immobilization and recovery in the larger bears. The larger bears were more sensitive to succinylcholine chloride than either the small or the medium-sized ones. The build-up of body fat throughout the summer also seemed to have an effect on dosage.

Grizzlies were individually color marked by slitting the base of each ear and inserting polyvinyl chloride tape. Each marker consisted of an ear loop and a tail of a different color, secured with rivets. Both visibility and retention were excellent, and most marked bears probably went into hibernation with their color markers intact. One hundred and sixty observations were made of color-marked bears yielding information on range, population composition and behavior. During the same time only two bears were retrapped. A yet more durable color marker was made from polyethylene diamond braided rope and will in the future be used experimentally for ear markers.

The largest bear trapped weighed 710 pounds. The greatest distance exceeded 50 air miles over the rugged Absaroka Range in Wyoming.

LITERATURE CITED

Black, H. C.
1958. Black bear research in New York. N. A. Wildl. Conf. Trans. 23:443-461.
Cooney, Robert F.
1956. Wilderness monarch. Montana Wildlife VI:14-17.
Craighead, J. J. and D. S. Stockstad
(Unpublished). Color marker for big game.
Crockford, A. J., Frank A. Hayes, James H. Jenkins, and Seldon D. Feurt
1957. Nicotine salicylate for capturing deer. J. Wildl. Mgmt. 21:213-220.
Erickson, A. W.
1957. Techniques for live-trapping and handling black bears. N. A. Wildl. Conf. Trans. 22:520-543.
Grollman and Slaughter
1947. Pharmacology and therapeutics. 868 pp. Lea and Febiger, Philadelphia, Pa.
Jonkel, Charles and Vern Hawley
1960. Personal communication.
Murie, O. J.
1954. Progress report of the Yellowstone bear study. Unpublished.
Skinner, M. P.
1925. Bears in the Yellowstone. 158 pp. A. C. McClurg & Co., Chicago.
Storer, T. I. and L. P. Trevis, Jr.
1955. California grizzly. 335 pp. Univ. of Calif. Press, Berkeley, Calif.
Troyer, Will
1960. Personal communication.

DISCUSSION

MR. GILBERT HUNTER [Denver, Colorado]: Did you kill any bears in the process of your trapping by overdosage?

DR. CRAIGHEAD: Yes, we did. It's hard to determine, however, just what is an overdosage. One very large and very old bear, we are certain that we killed with an overdose, although we administered a dose that was considerably less than one milligram for three pounds of body weight, which we found to be fairly optimum.

We killed a cub. We shot it free roaming, immobilized it, got it back where we could work on it. It started to come around, was bawling, and the sow was not very far off, and this was in the middle of the night, so we quickly gave it another injection and it proved to be too much. However, it didn't die until we had completely marked it and obtained the data we wanted. It seemed to be in good shape, was coming out of it, was able to struggle, and it was all we could do to hold it down, and then it suddenly stopped breathing.

We gave it artificial respiration, but failed to bring it around. Then there was a sow which we shot free roaming with a light dose of less than the one milligram per three pounds of body weight. She ran off, and just as the drug took effect, started to cross the stream. It was more than waist deep. She fell in. We had to rush down there and haul her out because she couldn't lift her head.

We got her out, and she came around finally, but we dragged her to the culvert trap, deciding we would hold her overnight. She had cubs, and we thought we could trap the cubs by holding the sow. We were unable to do that. Then in order to mark her and release her, we gave her another injection. This was about 36 hours later. It was considerably less than the dose we had given the first time, and we thought we would have no trouble with her at all, and she developed apnea, and artificial respiration did not bring her around either.

In this instance we suspect that she was not able to expel the CO_2 when we gave the artificial respiration, and it looked as though possible fibrillation of the heart occurred, but there is a lot that we have to learn about the cause of death in these bears. In relation to the ones that died, there were a number that would have been shot in the park—at least four or five that wandered into camps—which we were able to immobilize and move to other areas; thus they were saved, so the net gain was some grizzlies.

MR. STEPHEN BROWN [New York]: I may be able to add some information to that last question.

I spent last summer with Will Troyer trapping Kodiak bear and the previous summer with Hugh Black in New York, and I have handled 30 Kodiaks and approximately 120 black bears. We never lost a bear, which was a pretty good record. We had only one in New York that stopped breathing which was apparently from sensitivity to ether, which we were using at that time.

We also used sodium pentabarbitol and succinylcholine chloride on the bears, and we used approximately the same dosages of succinylsodium chloride that Dr. Craighead did with very effective results on both of the bears.

MR. GORDON FREDINE [National Park Service, Washington, D. C.]: The National Park Service is duly grateful for the fine work that John and his brother, Frank, and the others have been doing in Yellowstone. We certainly will support it, and continue to hope that they can continue their work there, but I want to mention the fact that the problem of conservation of the grizzly bear in the United States is a very serious one.

I hope that this study is just a springboard to a long-range study of the grizzly bear throughout its remaining range in the United States, and although you always appoint a committee when you need to do some work, I really think it might be a good idea for the varioust people in the states of Montana, Idaho, Wyoming and Colorado where we still have some grizzlies to get together and exchange ideas and form a program which will yield the information that we might be a good idea for the various people in the states of Montana, Idaho,

DR. CRAIGHEAD: That is an excellent idea, Gordon, and I certainly want to thank you and the National Park Service for the fine cooperation we had and help and particularly the freedom to conduct research in the manner that we were doing last summer.

One of the objectives of this study will be to study a population under reasonably natural conditions to determine population structure, perhaps carrying capacity; and this information should prove very valuable when applied to other areas where the grizzly is still fairly abundant.

With regard to the previous question, I would like to say that I have discussed with Will Troyer his work on the brown bear. He has done a tremendous job. They used succinylcholine chloride and Halatol. He did not have any known losses. However, the bears were out for a long time, and we did leave before the bears actually came to in many cases, and so I am not sure that he can state flatly that he had no mortality, but it does look like a combination of the two drugs may be more effective than simply using one, but there is a lot more experimentation we will have to do before we are certain of that.

AN EVALUATION OF COLORADO'S ACCESS PROBLEMS[1]

KEITH G. HAY
Colorado Department of Game and Fish, Denver

"We were full two hours in reaching Valmont (by saddle horse in 1865), on account of the very independent habits of Colorado farmers. The second bottoms being devoted to grazing purposes, they have found it necessary to fence the outer edge of the farm land; and, in so doing, they cut off the road with the most utter disregard of the public. If there are laws in relation to roads, they seem to be a dead letter. That which should be the first business of a territorial government, is left to a time when it can only be regulated by a great deal of trouble and expense."

Bayard Taylor, 1867[2]

In Colorado, nearly 100 years ago, the problems of access denial to land areas began to spawn trouble. Private and public holdings, their geographical locations so situated that the interests of each may be mutually affected, have given birth to a conflict of freedoms in many western states.

In 1957, after years of public concern over the increasing loss of free access to Colorado's public lands[3], the state legislature established a committee to analyze this problem. Through the Game and Fish Department and its state-wide field force of conservation officers this evaluation was made. The results (e.g., 1½ million acres of public land were found blocked to free public access) were submitted to the Colorado General Assembly in January, 1959. Proposed remedial action was promptly defeated in both houses of the legislature.

This paper endeavors to define the factors responsible for this conflict in Colorado; to examine and evaluate the problem; and to make recommendations toward its solution.

THE CONFLICT DEFINED

Colorado completed its "Rush to the Rockies Centennial" in December, 1959. In 1859, the discovery of gold and silver had brought the hardy and adventurous to the Centennial State by the thousands. But the rewards from prospecting were short-lived for many—the returns from homesteading and cattle raising, although slower, were

[1]Portions of this paper were presented at the 39th Western Assoc. of Game and Fish Commissioners Meeting, Portland, Oregon, June, 1959.
[2]Excerpted from *"Colorado—A Summer Trip"* by Bayard Taylor, G. P. Putnam and Son, 1867.
[3]Hunting and fishing on private land will not be discussed, as the right to control trespass by the landowner is a basic tenet of Colorado law. Public lands comprise 39 percent of the state's total area.

far more certain. As a result, homesteads began to spring up throughout the lush valleys and stream bottoms of the public lands. The large timbered areas were later consigned to national forest status; and smaller chunks of intermingled federal land at lower elevations were placed in custody of the Bureau of Land Management. Thus, today, our federal lands, large and small, might be considered public islands in a sea of privately-owned property. Recreationists enter these public lands via both public and private roads. As roadways generally follow valleys and stream bottoms, access routes, aside from main highways, are usually confined to private property.

Access is a vital key in managing our wildlife resources. Owners of contiguous lands, however, stand as "ports of entry" around these regions—screening, charging, permitting, or prohibiting entrance as they see fit. Fortunately, the majority of landowners are cooperative and do not prohibit ingress and egress. And those that do deny access are simply exercising their legal right as land-owners to control trespass and to protect their property and privacy. On the other hand, the public has title to public land, as citizens, but in the majority of states, practical routes of entry can legally be obtained only through negotiated or condemned rights-of-way.

Consequently, a conflict of freedoms has arisen, with far-reaching implications and with no simple solution; and it transcends hunting and fishing to dwell in the realm of public and private rights and future needs. In many of the western states, where the major portion of the wildlife resource is confined to the public lands, the situation has become acute. It requires no imagination to see the implications certain to be compounded by population increase, greater demand for outdoor recreation, and increased worth to individuals situated so as to profit from proximity of private and public-land holdings.

CAUSES OF THE PROBLEM

Factors contributing to the denial of access are as follows:

1. The growing demand by the public for outdoor recreation has forced landowners to control and protect their property from the irresponsible acts of a small segment of the recreational users.

2. Landowners have recognized the economic potential of hunting and fishing on their land and contiguous public land. Commercialization has resulted, and fees are being charged for access privileges to both types of land. By controlling access, virtual game preserves can be established and built up, and fee-paying hunters seeking such areas represent additional income reaching, in some cases, to thousands of dollars annually.

3. Many landowners prevent access simply to maintain good hunting and fishing for themselves and friends. This is especially true of nonresident Colorado landowners from our second largest state to the south.

4. Private roads into public lands cannot be maintained for the benefit of the public at the expense of the landowners. Naturally such roads are closed. In many areas, public roads entering the federal lands are few and their maintenance is poor.

In addition, poor administration, failure of the Interior and Agriculture departments to recognize access obligations, and a general lack of funds have all contributed to the problem and to underdevelopment of the public lands for recreational purposes.

EVALUATION TECHNIQUES

Our Department's pioneering techniques to evaluate access problems should constitute only a working basis for evaluations by other states, as methods must be attuned to the needs and objectives of the state concerned.

The primary objective in Colorado was to obtain an accurate, detailed, and impartial investigation. The facts, then, were to be condensed and presented in an easily understandable report for consideration by our lawmakers. The information comprising the report was obtained from State and Federal government agencies, complaints from individual sportsmen, and one national and six statewide surveys.

Map Surveys

Wildlife conservation officers were individually contacted regarding blocked areas within their districts. Small-scale (1 inch = 2 miles) county maps were studied, and the approximate areas of public lands blocked to reasonable public access were shaded in red. Without a specific definition to work with, lands blocked to "reasonable access" were understood to mean those portions of the public lands where free public access was denied and where entrance could be obtained only after extended foot or horseback travel from another direction. The delineation of distances and areas was left largely to the field men, who were more than generous in their estimate of the average sportsman's ability to walk. As a result, the size of areas recorded blocked was ultra-conservative.

The owner or owners names were placed on the map, a number assigned thereto, and locked gates, blocked roads, etc., were pinpointed.

Remarks as to game-depredation history, species of game or fish involved, and the quality of hunting or fishing were also recorded. With the above information it was then possible to compute rough acreage figures, record location, and complete forms for each county as shown in Appendix (Form 1). After summation of the data, we found 150 blocked areas in 28 (out of 63) counties, amassing a total of 1,462,720 acres.

For a true evaluation of the extent of federal lands reported blocked in relation to all federal lands in Colorado, a second map survey was made. This survey attempted to equalize such a comparison from a hunting and fishing standpoint. That is, most of the blocked federal acreage lies in good to excellent hunting and fishing regions, and therefore should be compared to only that portion of the total federal land that contains the same quality of hunting and fishing.

The survey considered land classes in this manner: Forest Service land classifications revealed the number of acres in each forest classed as "Other Lands," *i.e.,* regions such as high altitude rocky areas, swamp, brush, and barren lands having little or no commercial value for forestry, grazing, or recreational uses. The total acreage of such land for each county was then calculated and deducted from the total national-forest acreage for each county. Bureau of Land Management figures within grazing districts were used in total.

Considering these deductions, Game and Fish Department field personnel were asked to define the caliber of hunting and fishing on the federal lands with which they were intimately acquainted. Extensive map analysis revealed that 80 per cent of the forest land and 62 per cent of the B.L.M. land could be considered good hunting or fishing.

From the figures so derived, 12 per cent of the federal lands classified as good hunting or fishing in Colorado were found inaccessible to the public. Percentages ran from as low as 0.34 in one county to as high as 98.1 in another. In one county seven landowners prohibit access to some 77,500 acres of the Arapaho National Forest; and in another, two ranches control entrance to 70,720 acres of B.L.M. land.

TABLE 1. NUMBER OF 1958 DEER AND ELK HUNTERS REPORTING LOCATION OF KILL

Big-Game Check Station	PUBLIC LAND			Private Land	Total
	Forest	B. L. M.	State		
Total					
Percent					

Municipal watershed closures also came to light as no small factors in the over-all problem. Five different municipalities block access to some 53,000 acres. The reason for these closures: to keep the watershed and the water reservoirs free from human-caused fires and pollution. The logic behind such reasoning has been refuted by long-standing examples in numerous states over the nation.

Use of Public Lands by Hunters

To show the importance of public lands in relation to hunting pressure a third survey was made. During the 1958 big-game season nearly 30,000 deer and elk hunters were questioned as to the type of land they had hunted on, *i.e.,* National Forest, B.L.M., state, or private. Data was tabulated under headings shown in Table 1.

The findings disclosed hunting pressures by land ownership classes and indicated that 80 percent of the big game was killed on federal land—62 per cent on National Forests and 18 per cent on B.L.M. land. A similar 1959 survey revealed nearly identical figures.

Effect on Big-game Management

Needless to say, hunter access is imperative to proper game harvest. The effect of prohibiting such access to federal lands was disclosed by data in Table 2.

TABLE 2. A COMPARISON OF 10 COLORADO COUNTIES CONTAINING THE HIGHEST AVERAGE OF BIG-GAME KILLS AND THE LARGEST AMOUNT OF BLOCKED LAND

Ten Top Big-Game Counties	Rank	Ten Counties Containing the Largest Amount of Blocked Land	Rank

From an eight-year average of deer and elk harvests, the 10 top counties were selected in terms of highest kills. These counties were compared to the 10 counties with the largest amount of closed land. Seven of the 10 best big-game hunting counties were also among the 10 counties containing the largest amount of blocked land. Thus, some of Colorado's finest hunting land is also its most inaccessible. And despite the high kills recorded, an even greater harvest was needed, for these closed areas have long been responsible for over-

[4]In Colorado the Game and Fish Department is required by law to pay landowners crop damage incurred by protected game species.

populations, poor winter-range conditions, and costly crop depredations.[4] The latter condition is revealed by data in Table 3.

TABLE 3. TEN-YEAR (1948-58) RECORD OF GAME DAMAGE PAYMENTS TO INDIVIDUALS BLOCKING ACCESS TO FEDERAL LAND IN 28 COLORADO COUNTIES

County	Number of Landowners Filing Claims; Complaints	Number filed	Number paid	Number pending	Total Paid
Totals					

During this ten-year period, 80.3 per cent of the monies paid for game damage to crops was received by individuals in the 10 counties containing the most blocked land.

Effect on Fishing

More people fish than hunt in Colorado, and the closure of choice fishing waters affects a tremendous segment of both our resident and nonresident fishermen.

Fish biologists affirm that under-harvesting a trout fishery has little or no harmful results. The fish population tends to become stable with natural mortality instead of the fisherman harvesting the crop. The wasting of this valuable resource on federal lands, in the face of increasing fishing pressure on waters now open to the public, is the main consideration.

To determine the extent that Colorado streams were barred to public use, a stream survey form was designed and the information collected by Department field men (Appendix, Form 2). Result: 522 stream miles of good trout fishing and 28 lakes on public land were blocked to access by the posting of riparian landowners.

Landowner Right-of-Way Survey

This inquiry was conducted to determine how many of the 236 landowners prohibiting access would sell or negotiate to provide rights-of-way to public land. Other pertinent questions were asked (See Appendix, Form 3). Results: 87 per cent of the landowners refused to sell or provide access to public land. Those who agreed to sell asked prices ranging from $500 to $1,500 per acre, although some agreed to sell for market values. Average length of access road was 2.3 miles. Thirty individuals admitted charging trespass fees varying from $1 to $25 per person. A far greater proportion of landowners demand trespass fees, although the charges are variously disguised as road repairs (often justified), emergency location service, camping fees etc. Nonresidents are especially vulnerable to such charges.

Nation-wide Survey

Questionnaires were sent to all State game, fish, and conservation departments asking what percentage of their public lands was available to free hunting and fishing. From the 46 replies, a national average of 82.17 per cent of the public lands was found open to free public access. Twenty-six State departments of the 46 (or 56 per cent) reporting have the power to acquire private lands through legal condemnation procedures.

Statistical Summary

A statistical summation of certain results was compiled on a three-page fold-out under five separate headings. This summary proved a ready reference for county totals and percentages. (Appendix, Form 4).

PROBLEMS ENCOUNTERED

What constitutes "easily accessible land?" The problems of obtaining a practical definition of such land are many and extreme interpretations are frequent. The condition of mountain roads is a major consideration; and, even with exhaustive ground surveys, figures so derived change continually with the weather, new road construction, land sales, and posting policies.

Bureau of Land Management lands posed distinct problems. It is impossible to distinguish between private land and adjoining B.L.M. land in countless situations over the state. The average sportsman, therefore, considers an undetermined amount of this federal land to be private. In many cases, such public land is managed by the lessee as private land, *including the control of trespass.*

Current proposals by the Department of Interior to post B.L.M. land in Colorado will meet with some unique and difficult problems. In one large area, an intermingled hodgepodge of freak geography and ownership permits oil company properties, oil company leases, private leases from oil companies, B.L.M. lands, Naval Oil Shale Reserve lands, and patented lands to exist in one grand medley of real estate. To top it off, county clerks are often years behind on land-status records, and the latest government surveys in some areas were made prior to or shortly after the turn of the century. Most of the land is not enclosed, and a survey corner, delineating federal from private property is often an unknown spot in a sagebrush flat. The cost of resurveying these lands would be tremendous; and without the establishment of legal boundaries, land owners will be reluctant to permit posting. This situation, however, should not preclude the posting of B.L.M. lands with proper signs where it is presently feasible.

Colorado State School lands, acquired by grants from the federal government, comprise nearly three million acres. Much of land affords good to excellent hunting and fishing, but virtually all of it is under lease to private parties. Lessees are given *absolute control* over all ingress and egress on these lands. This is in keeping with the State Land Board's refusal to recognize state land as public land and allow management policies to be established accordingly.

RECOMMENDATIONS

The problem will not be solved to the satisfaction of all parties by any single act. Each situation must be considered individually and *all* avenues of conciliation should be explored to gain "amicable access." By employing such measures, the Department is confident the problem could be greatly reduced. The following are suggested courses of action that may be taken by the various parties involved:

1. Construct and maintain more public roads serving the public lands. The responsibility for this should be borne primarily by the Federal Government, with state and county assistance. Access for the people should be provided by the people.

2. Initiate the policy that permanent roads constructed to harvest timber on federal lands be designated as public roads. This action would be the responsibility of the Forest Service and B.L.M. and should be accompanied by Congressional appropriation of necessary funds to improve and maintain these roads.

3. Suggest to government agencies dealing in leases or permits involving public land that they require private parties to grant, where possible, reasonable access to the public land as a condition of lease or permit to use this public land.

4. Grant limited eminent domain powers to state game and fish commissions.

5. Strengthen landowner cooperation by: (1) providing some recourse for actual damages caused by sportsmen. The plan could be handled by the organized sportsmen; (2) urging local and federal agencies to assist landowners in maintaining private roads serving public lands.

6. Strengthen quantity and quality of public education programs devoted to improving the rapport between sportsmen and landowners.

This is a responsibility not only of sportsmen's organizations and game and fish departments, but of other land-use agencies including national, state, and local livestock and farming organizations. Courtesy, common sense, and a concern for the rights of others must be stressed above all.

7. Initiate uniform federal and state fencing and marking regulations. Such regulations and their implementation would serve to idenitfy public lands for increased recreational use.

8. Simplify lease agreements, land exchanges, and sales between landowners and the federal government. This would help to lessen the confusion of ownership and access to small intermingled tracts, and permit the blocking out of federal lands for better management.

SUMMARY AND CONCLUSIONS

In 1957-58, at the request of the State Legislature, the Colorado Game and Fish Department conducted an inventory of public lands blocked to free public access. One national and six state-wide surveys were made. This paper defines the problem and its causes and discusses the techniques used in its evaluation. Surveys concerned blocked areas, recreation quality, hunting, game damage, fishing, landowner, and nation-wide access information.

The problem was found to exist in 28 of Colorado's 63 counties. A minimum of 236 landowners were found to be blocking access to 1,462,720 acres of public land. This total comprises 12 per cent of all federal lands that are judged good to excellent from a hunting and fishing standpoint.

A survey of nearly 30,000 big-game hunters revealed that 80 per cent hunted on federal land in Colorado.

More than half (62.1 per cent) of the B.L.M. lands and 80 per cent of the forest lands were classed as "good" hunting and fishing.

B.L.M. lands, because of their unmarked geographical location in relation to contiguous private lands, posed difficult access and posting problems. In many cases landowners manage the adjacent federal land as their own—including the control of trespass.

Some of the state's best hunting country also contains the greatest amount of blocked acreage and game-damage problems.

The public is denied access to 522 miles of "good" trout-stream fishing and 28 "good" fishing lakes on federal land due to posting on private land.

Eighty-seven per cent of the landowners refused to grant or sell right-of-ways to public land.

Large sections of Rocky Mountain National Park, Colorado State

Forest, and Colorado school lands were found barred to the public by the owners of intervening private lands.

An average of 82.17 per cent of the Nation's public lands was found open to free public access. Twenty-six State conservation departments have the power to purchase lands through legal condemnation procedures.

To mitigate the problem, several courses of action are possible: (1) improve existing roads and provide new ones—a responsibility of federal land-use agencies; (2) strengthen cooperation with landowners in numerous ways; (3) establish uniform regulations for identifying public land; (4) grant limited condemnation power to Conservation departments for right-of-ways; and (5) increase and simplify lease agreements, land exchanges, and sales between landowners and the federal government.

Colorado and other western states have increased in growth and industry largely because of their reputation as a place to live and enjoy the out of doors. Hunting and fishing as a recreation is currently climbing at a rate in excess of our population growth. The public lands represent this Nation's last and best stronghold for this now rare type of free public recreation. To protect from special-interest groups, to manage properly, and to increase accessibility are the vital issues affecting the future of these public lands. Needless to say, to insure their future will require constant vigilance and vigorous, intelligent effort.

ACKNOWLEDGMENTS

Without the splendid cooperation of our Game and Fish Department field personnel, Colorado's access report could not have been made. For additional survey information, invaluable assistance, and cooperation, appreciation is extended to: Thomas L. Kimball, Director; Gilbert N. Hunter, Game Manager; Clyde Slonaker, Regional Conservation Officer; and Ralph R. Hill, U. S. Forest Service, and Lee E. Yeager, U. S. Fish and Wildlife Service.

Excellent cooperation was received from the U. S. Forest Service, the Colorado Wildlife Federation, and numerous individuals who reported areas closed to public access.

APPENDIX

(Information entered on the survey forms is designed for illustrative purposes only. Names and remarks have been edited to create anonymity.)

Report on Denial of
Free Access to Public Lands
in Colorado

County: Rio Blanco

No.	Public Land Involved	Location of Area	Access Controlled by	Approx. Acres of Public Land Affected
1	White River Natl. Forest	T. 38 N., R. 5 E.	Elmer G. Field	32,800
	Remarks: Goose Creek and tributaries are blocked south of Horse Shoe Gap. Excellent elk hunting and good trout fishing. This large blocked area hampers proper harvest of the elk herd. Owner will not sell access route, stating that a "fenced right-of-way will divide pasture." Has history of payments for game damage.			
2	Bur. of Land Management	T. 40 N., R. 7 W.	Mrs. Carl Wray	12,160
	Remarks: This area blocks access to Slate, Decker, and Jumper Creeks. Good deer hunting and fishing. Landowner refuses to sell access route. Estimated length of necessary route is 3/4 mile. Owner is tired of so much public use.			
3	White River Natl. Forest	T. 39-40 N., R. 9 W.	John and Robert Long and Jack Bailey	7,040
	Remarks: These landowners close public ingress to all of upper Lester Creek and the west branches of Beaver Creek. Both good hunting and fishing is restricted. One owner runs guide service to public lands. Packaged deal for hunters $20 per day. Owners refuse to sell right-of-way.			
4	White River Natl. Forest and Bur. of Land Management	T. 40 N., R. 8 E.	Art Murphy Bill Johnson Ralph Ives Stan Lowe Roger Stover	18,200
	Remarks: The locked gates and restricted access roads of these parties control a prime deer and elk hunting area in the heart of the White River elk herd range. Access to good stream fishing is also impaired. Three of above landowners charge a $10 "trespass" fee. Two parties refused to answer survey questions, remaining three refused to sell access route.			

Form No. 2

DISTRICT STREAM SURVEY REPORT

Name (or names) of streams covered, and boundaries of area covered Williams Fork Drainage - Beaver, Pine, Sandy, Whiskey and Trout Creeks covered.

How many miles of trout stream are there in your district? 32

How many stream miles on private lands? 16 Of streams on private lands, how many miles are posted? 10 How many miles unposted? 6

How many miles are posted by sportsmen who have bought land or leased fishing privileges? None How many miles are accessible by auto? 22 Of this total, how much is posted? 8 How many miles may be considered "good" trout fishing? 25 Of this total, how many miles are posted? 10

Determine how many lakes are closed to public fishing None.

PUBLIC LANDS: How many stream miles on public land are blocked by posting on private land? 7 How many lakes on public land are blocked to public access by posting on private land? None

Analysis

Please comment on the effect of posting on public fishing in your district The streams involved, mostly Trout and Sandy Creeks, are excellent trout fishing, especially late in the season. One landowner charges $1 per head to fish. Others blocking access refuse all fishermen just don't want to be bothered they say.

N. W. Johns W.C.O
District Officer

Eagle, Colo
Location

Form No. 3

LANDOWNER RIGHT-OF-WAY INQUIRY

Name: Mr. John C. Kaufman

Location: T20, 21 N., R. 10 E.

Access to: San Isabel National Forest

1. Would landowner* negotiate to provide unproductive land for the construction of a fenced 30 foot right-of-way to public land. Yes ☐ No ☒

2. Would landowner sell suitable portions of his property for the construction of a fenced 30 foot right-of-way to public land. Yes ☐ No ☒

   If yes, what is the approximate asking price $________.

3. Approximate length of access road through the private property concerned 1½ miles.

4. Does landowner use the public land noted above: No ☐ Yes ☒ --for grazing ☒, timber ☐ or mining ☐

5. Does landowner allow guests access through his property to hunt or fish on public land. Yes ☐ No ☒

6. Is access to public lands extended in conjunction with lodging or services provided by landowner. Yes ☐ No ☒ If yes explain:________

7. Is a usage, or trespass fee charged. Yes ☐ No ☒ If yes, amount per person $______, per vehicle $________.

Remarks: I have discussed this locked gate with Kaufman numerous times. Have been denied access during deer season for several years — even for official use.

N. D. Johns W.C.O.

PERSON MAKING CONTACT

* Or lessee.

STATISTICAL SUMMARY

Supplemental Report on Denial of Free
Public Access in 28 Colorado Counties

1.) Total Acres of Federal Land

COUNTY	National Forest	Bur. of Land Management	Total	Natl. Forest Barren Land	Total Minus Barren Land

2.) Percentage of Federal Land Considered Good Hunting or Fishing

National Forest		Bur. of Land Mgt.		TOTAL	
Percentage	Acres	Percentage	Acres	Percentage	Acres

3.) Number of Acres Blocked

Natl. For.	B. L. M.	Total

4.) Number of Blocked Areas

Natl. For.	B. L. M.	Total

5.) Percentage of Federal Lands Considered Good Hunting or Fishing that are Blocked

Natl. For.	B. L. M.	Total	COUNTY

(Headings were arranged side-by-side in lineal order for county comparison.)

EFFECTS OF RIGHTS OF WAY TECHNIQUES ON VEGETATION[1]

DALE HOWARD ARNER
Soil Conservation Service, Selma, Alabama

Today there are millions of acres of rights of way of power lines. telephone cable lines, and oil and gas pipe lines that crisscross our country-side. They cut through wilderness areas and through farm lands. In the State of Alabama alone, five major utility companies report over 240,000 acres of right of way. This large acreage possesses a tremendous potential for the production of food and cover for game birds and mammals. This study was initiated to investigate the effectiveness of several techniques in producing wildlife food and reducing objectionable plants.

Most rights of way are not owned by the utility companies. The utility company is granted an easement to establish and maintain a right of way with a line. The owner of the property retains title to the land, and is permitted to utilize it in such a manner as will not interfere with the maintenance of the line by the utility company. The utility companies are interested in keeping the rights of way sufficiently free of woody vegetation to provide easy access to lines for inspection and repair.

Gas companies with pipes underground carrying natural gas have two major problems in right of way maintenance. The first is the maintenance of a low herbaceous cover so that gas leaks, which create an easily distinguishable change in color of the vegetation, can be detected by weekly air patrols over the lines. The second is the control of erosion in hilly areas. Many of the gas companies have made no effort at revegetation but have attempted to control erosion by constructing terraces with sandbags and by hand filling with soil in badly eroded areas. They hope for the natural establishment of a low herbaceous covering of native plants. In many highly erodible soils of the Southeast this does not occur for several years; in some areas it is doubtful if it will ever occur. One line superintendent in Alabama said that if erosion were under control on his section of line he could reduce his crew by one-third.

The methods used by utility companies to keep their lines free of objectionable woody vegetation are varied. They include spraying with herbicides, hand cutting, bush hogging, and bulldozing. The

[1]A joint contribution of the Maryland Game and Inland Fish Commission, Pennsylvania State University, Auburn University, and the U. S. Soil Conservation Service which supported the work. The work at Auburn was with the Alabama Cooperative Wildlife Research Unit, the Alabama Department of Conservation, the Wildlife Management Institute, and the U. S. Fish and Wildlife Service cooperating.

greatest emphasis has been on the use of chemical sprays. This, possibly, has been due to the advertising and salesmanship conducted by many of the large chemical companies.

The following information concerning right of way maintenance was obtained from four large utility companies, three in Alabama and one in Maryland.

(1) 2,4-D and 2,4,5-T in fuel oil were the most common herbicides used. The usual procedure was to apply an initial foliage spray with costs ranging from $65.00 to $95.00 per acre. This was followed after two or three growing seasons by a basal spray. The cost of this follow-up spray ranged from $45.00 to $85.00 per acre. Additional follow-up sprays were required at three- to six-year intervals. These were usually basal sprays.

(2) Hand cutting is still used by one company. This company, and others that had experimented with hand cutting, reported costs ranging from $18.00 to $59.00 per acre, with repeat cuttings every three years.

(3) Mechanical cutting—The costs of this method ranged from $12.00 to $60.00 per acre and it required the same cycle as hand-cutting.

(4) Bulldozing costs varied from $14.64 to $50.00 per acre. The low cost of $14.64 pertained to experimental work done with a new Rome KG blade on a D6 caterpillar tractor. Three hundred acres bulldozed and harrowed in Alabama required follow-up cutting of brush from the hills and flats at the end of four years and from the low spots at the end of two years.

Extensive field observations made in Maryland, Alabama, Pennsylvania, and West Virginia revealed that the plants which most frequently established dominancy after eradication of brush on rights of way in the Middle Atlantic and Mid-South States belong to the following genera: *Andropogon, Danthonia, Panicum, Carex, Pteridium, Comptonia, Erechtites.* Other co-dominant genera are *Vaccinum, Solidago, Dennstaedtia, Rubus.* In Alabama the dominant plant groups are usually grasses of the genera *Andropogon, Aristida, Panicum, Arundinaria, Sorghastrum.* Other co-dominant plant genera in Alabama include *Rubus, Diodia, Richardia, Pteridium, Chrysopsis, Solidago.* The period of dominance will depend upon the degree of control exerted on resurging or invading woody plants. None of these plants fill the important requirement for deer and turkey of a palatable, nutritious early spring green. In the Southeast scattered plants of native legumes such as partiridge pea, perennial despedeza, and beggarweed will occur with the perennial grasses. In all areas observed, however, over a six year period, the quantity of such desirable plants was too small to contribute significantly to the food of deer, turkey, or quail during the critical winter and early spring period.

In an attempt to find practical and economical maintenance techniques that would serve the dual purposes of (1) retarding the invasion of woody plants and, (2) providing highly nutritious food for wildlife, the following were tried in Maryland and Alabama:

(1) Bulldozing and seeding with various seed mixtures.
(2) Use of cultivator and heavy duty brush mower with seed and fertilizer.
(3) Use of pelleted and unpelleted seeds on areas previously sprayed with herbicides.
(4) Use of controlled burning, fertilizer, and seed.

BULLDOZING AND SEEDING WITH VARIOUS SEED MIXTURES

In the spring of 1948, Ernest Vaughan, Director of the Maryland Game and Inland Fish Commission, developed a plan of mutual cooperation between the Potomac Edison Power Company and the Game Commission, where nine miles of right of way through the Green Ridge State Forest was bulldozed at the expense of the Power Company ($40.00 per acre), and seeded with a pasture mixture by the Game Commission at a cost of $5.59 per acre. A three-year study[2] of this program, showed at the end of the third growing season that 52 quadrats, each 1 meter square, had nearly 50 per cent of the vegetative covering made up of the seeded species, and only 9 per cent was made up of the woody plants. At the end of the seventh growing season, only about 20 per cent of the area had required renovation because of the invasion of undesirable woody plants.

USE OF CULTIVATOR AND HEAVY-DUTY BRUSH MOWER

During the fourth growing season on the Maryland rights or way previously described, two methods of renovation were tried. The first method entailed the use of a spring-shank Ford Dearborn cultivator. On this implement the cultivators are attached to heavy springs which can snap the cultivators back when they strike rocks or other obstruction without causing breakage to the cultivator. This implement was very efficient in tearing up areas invaded by broomsedge and poverty grass.

Three plots were renovated in May with the cultivator. Each plot was approximately one acre in size. The soil type was Ashby silt loam. Three thousand pounds of ground limestone and 600 pounds of 20 per cent superphosphate were applied per acre. A mixture of

[2]Reported at the 16th No. Amer. Wildlife Conference, Arner, 1951.

orchard grass, Korean lespedeza, perennial rye grass, alsike clover, and sweet clover was sowed on each plot. Three additional plots on identical soil types were given the same applications of fertilizer and seed in late May and then mowed. The cost of renovation by cultivator with fertilizer and seed was $29.00 per acre. The cost of mowing, fertilizing, and seeding was approximately $28.00 per acre.

At the end of the second growing season the plots were sampled by clipping, and oven-dry weights were obtained for major plant groups. The results showed that the plots which were renovated with the cultivator had nearly three times as much of seeded species (817 pounds per acre oven-dry weight) as the mowed plots, which weighed only 278 pounds per acre. Korean lespedeza and orchard grass comprised over 87 per cent of the seeded species of both treatments (Arner, 1954).

USE OF PELLETED AND UNPELLETED SEEDS ON AREAS PREVIOUSLY SPRAYED WITH HERBICIDES

There was considerable acreage of right of way in western Maryland too narrow, steep, or rocky for bulldozing to be practical. It was thought that the use of herbicides sprayed selectively would be the most practical means of controlling objectionable woody plants. Two techniques were tried to establish desirable plants on the sprayed brushland.

The first technique consisted of the use of grass and legume pasture mixture in pelleted form. The pelleted seeds were sowed on rights of way which had been treated by two successive sprays of herbicides. This included a foliage and a basal spray. A major portion of the standing brush was dead, ground cover varied greatly, ranging from an estimated density of 30 per cent to 70 per cent. The herbaceous plant species present varied but the majority of the dominant plants belonged to the genera of *Andropogon, Danthonia,* and *Pteridium.*

The Filtrol Corporation of California (now the Germain Seed and Plant Company) cooperated in this experiment and pelleted the seeds free of charge. Two hundred twenty-five pounds of seed of a mixture containing orchard grass, Korean lespedeza, red top grass, creeping red fescue, perennial rye grass, birdsfoot trefoil, and Alsike clover were pelleted by a process known as Filcoat. The weight after pelleting was 1,115 pounds. Filcoat seed was developed primarily to facilitate precision planting of row crops, particularly vegetables which require a definite spacing in rows. According to correspondence from F. W. Burgesser of this corporation, they had previously done some work in pelleting legume and range grass seed. At the time of correspondence (1952) the pelleting of seeds for range sowing had not been entirely successful. It was thought that the lack of success was chiefly due to the method used in producing the pellet. This involved the application of pressure which was apparently depressing the total seed germination. Mr. Burgesser informed us that at that time the company was developing new equipment which they believed would overcome this objection. The Filcoat coating material has affinity for soil moisture. It would reportedly draw moisture from the soil, since it had a much greater water absorption capacity than the soil. A second reported characteristic is the rapid softening and swelling of the coating material when moistened. These properties would permit the coating to hold moisture to the seed and allow the seed to germinate.

In all areas selected for observational seeding, one-half of the area was sowed with pelleted seeds and the other half was sowed with unpelleted seeds of the same species and in the same amounts. Observations made during the summer and early fall showed poorer germination and decidedly fewer seedlings on the plots sowed with pelleted seeds than with the unpelleted seeds. It was observed on many occasions that robins, sparrows, and starlings were eagerly picking up the white coated seeds. It is my opinion that bird depredation plus lower germination of the pelleted seed has resulted in the poorer showing of the pelleted seeds over the unpelleted seeds. Improved processes of pelleting to increase the percentage of germination and the incorporation of bird repellents in the seed pellets could make the use of pelleted seed practical for sowing of grasses and legumes on rough terrain.

The second technique tried was that of using unpelleted seeds of some common native plants. The trials were conducted on rights of way in western Maryland on rough terrain where selective spraying had previously killed the brush. The species used were hog peanut [*Amphicarpa bracteata* (L.) Fern.], maple leaved viburnum (*Viburnum acerifolium* L.), hairy lespedeza [*Lespedeza hirta* (L.) Hornem.]

It had been observed on a number of occasions that hog peanuts were growing in association with bracken fern in woodland openings. This perennial legume vine would be found twining around the stems of the bracken fern. It was decided to collect the single-seeded pods, which mature like peanuts below the surface of the ground, and plant them with a hand corn planter in areas on the right of way where patches of bracken fern occurred. Twelve bracken fern areas were selected and in each area a milacre plot was staked off. The hog peanut seeds were planted in October and were spaced approximately

6 inches apart. Examination of plots the following spring and summer showed that 20 to 60 per cent of the seeds germinated and grew. The average was about 40 per cent. If an economical seed source for hog peanuts could be obtained, this plant upon further investigation, might prove to be well suited for sites such as the bracken fern areas on rights of way where bulldozing is impractical. This observer left Maryland before the hog peanut's effect on the plant communities could be fully ascertained.

Experiments with seeding of maple leaved viburnum over a four year period were a failure. Dried drupes and seed from mascerated drupes were used. Attempts were made through cold storage to break internal dormancy. The attempts at establishing hairy lespedeza by direct seeding on top of unscarified soils also resulted in failure. Both scarified (by abrasion) and unscarified seeds were sowed.

USE OF CONTROLLED BURNING, FERTILIZING, AND SEEDING

Research on controlled burning, fertilizing, and seeding on utility line rights of way was conducted in east central Alabama while I was a graduate student at Auburn University in 1956 and 1957. One experimental area was located on a portion of Alabama Power Company right of way in the Piedmont soils province. Two areas were located on Southern Natural Gas Company line right of way, with one on a sloping site and one on a nearly level site; both were in the Upper Coastal Plains soil province. Each area contained four blocks; each block consisted of four plots; each plot was one-twentieth acre in size, rectangular in shape, with approximate dimensions of 66 feet long and 33 feet wide. The blocks were located on areas of the utility line where the slope, exposure, soil type, and conditions were homogenous as was practical to select.

The treatments for each block consisted of burning two plots and leaving two unburned, fertilizing one of the burned plots and one of the unburned plots, and leaving one each of the burned and unburned plots unfertilized. The treatments for the plots in each block were selected at random. In addition, three of the blocks in each area were sowed with seed which were considered to be good quail food plants and which were believed capable of surviving without any land scarification (Kobe lespedeza, partridge pea, German millet). One block in each area received no application of seed. The treatments were repeated the second year. Soil samples were collected and analysis made by the soils testing laboratory at Auburn University. Applications of fertilizer were based on recommendations from the laboratory. Vegetative cover was measured both years by randomly selected line intercepts (Canfield 1941), modified as described by

Moore (1956). Analysis of variance was used to determine whether there were significant differences in the production of quail food plants between the seeded and unseeded plots. The "T" test was used for direct comparison between different treatments to determine whether one treatment showed significant differences over another treatment concerning pertinent groups. Although not in the original experimental design, field trials of burning, fertilizing and seeding were conducted in March, 1958 and 1959 on the Lower Coastal Plains soil province in south central Alabama.

Vegetative analysis for all the experimental areas showed coverage values were highly variable among plots and among the areas tested. It is believed the comparatively lower coverages of quail food plants in 1956 than in 1957 were due primarily to the unfavorable early growing season in 1956, when rainfall was below normal and hot dry weather occurred over a much longer period of time than in 1957. These conditions probably adversely affected the germination and survival of legumes, especially the seeded species.

Fertilizer appeared to be essential for survival and seed production of the seeded legumes of partridge pea and Kobe lespedeza. The use or lack of use of fertilizer was apparent in all areas tested, and especially so on the Upper and Lower Coastal Plains soil provinces. In these areas, unfertilized plots produced fewer seedlings of seeded legumes and practically none of the native species. Observations made during the early spring season revealed that many of the seeded legumes germinated on the unfertilized plots as well as on the fertilized plots; however, by late summer vegetational analysis showed that the survival of the seeded legumes on unfertilized plots was practically nil. Fertilization was also found to stimulate the production of native legumes and grasses of value as quail food. At the end of the second growing season, the majority of the fertilized plots had a greater coverage of native quail food plants than the unfertilized plots.

The information obtained from this study indicates that gas line rights of way normally have a sparser coverage of vegetation than power line rights of way. This is due to the bulldozing which mixes all the organic matter and the "A" horizon with the sub-surface horizons. Burning this sparse vegetative cover, even when fertilizer and seed are applied, is apparently unnecessary, and may even be harmful to the successful establishment of some quail food plants such as Kobe lespedeza. On certain exposures the need for some protective shade for Kobe lespedeza seedlings seemed to be indicated by the fact that most of the young seedlings were found grouped around the basal rosettes of panic grass. The seedlings which germinated in exposed areas totally devoid of partial shading did not survive in any number. Work by Geiger (1950), in Germany, has substantiated the value of even sparse shade to the survival of some seedlings. In 1957, both gas line rights of way had a higher average coverage of seeded species on unburned and fertilized plots than on burned and fertilized plots.

Since power line rights of way do not have the surface soil and organic matter completely removed or destroyed, they usually produce a dense stand of broomsedge or wire grass. Burning significantly reduced objectionable woody vegetation on the power line right of way in both 1956 and 1957. It was not until the second year, after fertilization and seeding had produced enough vegetative fuel for a hot fire, that significant reduction of woody plants occurred on the gas line rights of way. Prescribed burning is probably economically feasible only on rights of way one hundred or more feet wide and on land which is not too steep for the plowing of adequate fire lanes. Costs of controlled burning on rights of way could not be accurately ascertained from this study because of the limited number and size of the plots. Correspondence with foresters in the Southeast engaged in controlled burning revealed that their costs for burning of narrow strips ranged from $.70 to $1.33 per acre.

The percentage of bare ground vulnerable to erosion was lowest on the fertilized, seeded plots over the unfertilized, seeded plots for both years. However, it was not until the second year that statistically significant differences were established (Arner, 1959).

COOPERATIVE PLANNING

In Maryland, the cooperative program has resulted in the extension of the program between the Potomac Edison Company and the Maryland Game Commission over the entire state wherever state-owned forest lands were involved.

In Alabama, meetings between representatives of utility companies, Soil Conservation District Supervisors, and Soil Conservation Service technicians have resulted in plans for mutual cooperation. One natural gas corporation has agreed to pay for fertilizer, lime, and seed for 78 miles of new right of way where cooperators of Soil Conservation Districts will agree to apply the fertilizer and seed. Two power companies have agreed to set up pilot projects on approximately 14 miles of right of way to compare bulldozing and burning costs against spraying costs.

CONCLUSION

From the results of twelve years of investigation with mechanical equipment, sowing of pelleted and unpelleted seeds on sprayed areas, mowing, and controlled burning the following conclusions can be drawn. A greater amount of nutritious wildlife food can be produced and a more economical reduction of woody vegetation can be obtained through the use of mechanical equipment (bulldozer and cultivator) or controlled burning when these treatments are combined with the application of fertilizer and seed, than any other technique now in current use. Before selecting the techniques to be used in right of way management, topographic conditions, types and quantity of vegetation present, width of right of way, and the landowners' desires will all have to be taken into consideration.

LITERATURE CITED

Arner, Dale H.
1951. Experimental plantings on power line rights of way and woodland roads. Sixteenth N. Am. Wildlife Conf. Trans. 331-338.
1954. Experimental seeding of grasses and legumes for wildlife utilization. Unpublished Master's thesis, Pennsylvania State Univ. University Park.
1959. Experimental burning, fertilizing, and seeding on utility line rights of way. Unpublished Doctor of Philosophy dissertation, Alabama Poly. Inst. Auburn, Ala.
Canfield, R. H.
1941. Application of the line interception method in sampling range vegetation. Journ. For. 39:388-394.
Geiger, Rudolf
1950. The climate near the ground. Harvard Univ. Press, Cambridge, Mass.
Moore, William H.
1956. Effects of certain prescribed fire treatments on the distribution of some herbaceous quail food plants in loblolly-shortleaf pine communities of the Alabama Upper Coastal Plain. Unpublished Master's thesis, Alabama Poly. Inst., Auburn, Ala.

DISCUSSION

DISCUSSION LEADER ADAMS: Thank you very much, Dr. Arner, for that very informative paper. What, Dr. Arner, is the possibility of the companies who own or administer these rights-of-way of hiring ecologically competent personnel to undertake the administration and the management of these rights of way.

DR. ARNER: We are hoping that they will hire people who are trained in this particular phase of ecology, and there is some indication that they are, in the Northeast. I know of three companies which have hired foresters and trained botanists to work with the right-of-way maintenance. I don't know of any in the Southeast that have done so but I am sure there probably are some. I belive that in the future we will find that the companies will have people other than engineers to work on right-of-way maintenance problems

DR. H. F. LEWIS [Nova Scotia, Canada]: I do not come from any state, but from the Province of Nova Scotia. This paper is very interesting, and it covers a subject which is under very active investigation in Nova Scotia.

It seems to me that one of the serious drawbacks with which we must contend in connection with it is the very general failure to recognize esthetic values as something real and substantial, something that well deserves the expenditure plus substantial sums of money.

I would also comment that I regret to see all woody plants grouped together. It is our view that the most desirable cover when it is obtainable is one of low shrubs, some of which are excellent food for wildlife, some of which provide very attractive foliage, flowers and fruit along the highway, and which on the whole are much more resistant to reinvasion by trees, alders and other unwanted tall woody vegetation than is a cover of grass and forage.

A SALABLE APPROACH TO THE ELK-CATTLE COMPETITION PROBLEM

DALE A. JONES
Shoshone National Forest, Cody, Wyoming

Many times, perhaps because of the biological nature of our field, we search diligently for solutions when the truth of the matter is we really do not understand the problems.

Therefore, so no one will misunderstand the contents of this paper, let us first discuss what is meant by a salable approach to any given problem. For hints on selling techniques, it would seem only proper that we consult people whose business it is to sell things, mainly the advertising industry.

All we have to do is watch one evening of television commercials and the secret is obvious. Advertising relies on three basic points to sell products; namely, obtaining simple facts, presenting these facts in a manner adequate for public understanding, and sufficient repetitions so the facts will "soak in."

How many times have you heard "that after a nationwide survey, 9 out of 10 doctors agree that a certain brand cigarette contains less harmful lung irritants than any of the other leading brands", or "that after scientific tests 'X' filter completely eliminates 97.6% of all nicotine tars"?

Please don't jump to the conclusion that the author favors lowering the standards of our professions's fact-finding down to the cigarette manufacturers' level. Not because this method won't sell, however, for existence of such companies is good testimony that it will. The main difference is that stakes are much higher in our game. There are natural resources involved and we can't afford to be wrong. By the same token, public nonacceptance of information which would aid management has proven just as costly to our heritage.

We, therefore, find ourselves following a very narrow path in trying to find answers to proper resource management.

An example of a technique that seemed to guide us toward proper deer management, when the situation was hopelessly bogged down by public nonacceptance, was the twig-length measurement method for determining browse utilization.

In view of the small samples taken, each administrator fully realizes the limitations of this technique. He is also aware that research has devised range evaluation methods with improved statistical reliability. The ability of this simple transect to convince people that a management problem does exist, and that habitat is the important criteria to consider, has measurably helped the sale of deer management over the entire nation.

These were serious considerations given the grass range competition problem on the Shoshone National Forest by the Wyoming Game and Fish Department personnel and Forest Officials as they attempted to outline a fact-finding program to throw light on this age-old problem.

Before we go further, the problem referred to here should be clearly defined. Many of the key elk winter-spring ranges on the Shoshone are grazed summer-long by cattle. As a result, almost year-long use is made of these areas. The fact that total use has caused, and is causing a range deterioration problem is accepted by most people, but just what class of animal holds the major responsibility in this depletion trend has caused many arguments lasting into all hours of the night.

The word argument is really not proper here, for the dictionary defines it as meaning "to persuade by reasoning," and after hearing some of these discussions it can honestly be expressed that very little "reasoning" is used.

The land manager has a very definite responsibility when this type situation arises. He must pinpoint to the best of his ability where the problem lies, and let the "chips fall where they may."

Our first job was to separate the use made by cattle from that of elk. Fortunately no overlapping of season occurred, so the problem was minimized.

Studying the comparative weight differences between a protected and unprotected sample of forage is not a new technique in the range management field. The only obstacle we faced to employ this method was to develop a utilization cage that could be packed in sufficient numbers into roadless areas where the majority of our problem was centered.

Although a variety of wire and cage designs was tried, the final selection was a cone-shaped cage that could easily be packed unassembled. These cages were constructed by cutting half circles from 48-inch welded wire fabric, using a 48 inch radius. A cone is formed by folding the diameter line in half and lacing it together with light malleable wire. Twelve and one-half gauge wire with two by two inch mesh has proven to be adequate, but heavier gauge wire does possess advantages if it can be obtained.

As many as 25 of these cages can be packed on a single animal by stacking them open over a set of panniers (Figure 1). Only a matter of minutes is required to form the cone and stake it securely in place (Figure 2). The resulting protected plot is slightly in excess of 12 square feet.

Figure 1. Cages are easily packed for back country transportation.

Trend in forage production of key areas was made possible by clipping and air-dry weighing the sample of grass taken from a series of 9.6-square-foot plots centered under the cone cages.

Utilization by livestock is determined by clipping and weighing comparative unprotected plots after cattle use, but before elk move into the area. The clipping of a third plot in the spring affords data to calculate elk utilization.

Ten permanently located 1/100 acre pellet group plots spaced one chain apart were placed in each immediate transect area. It was hoped to correlate forage removed by elk and animal days use per acre.

This method, like most other range evaluation techniques, allows for human decision to set the pace for preciseness. Although an explanation will be given for the decisions reached, the reader should keep in mind that basically, ours was not a problem of separating the "fly specks from the pepper".

The subject of key area selection is probably worthy of a paper itself, but generally the following criteria were used to select study sites: ability for the area to show trend and evidence of past use by both livestock and big game.

Proper selection of comparable protected and unprotected plots is,

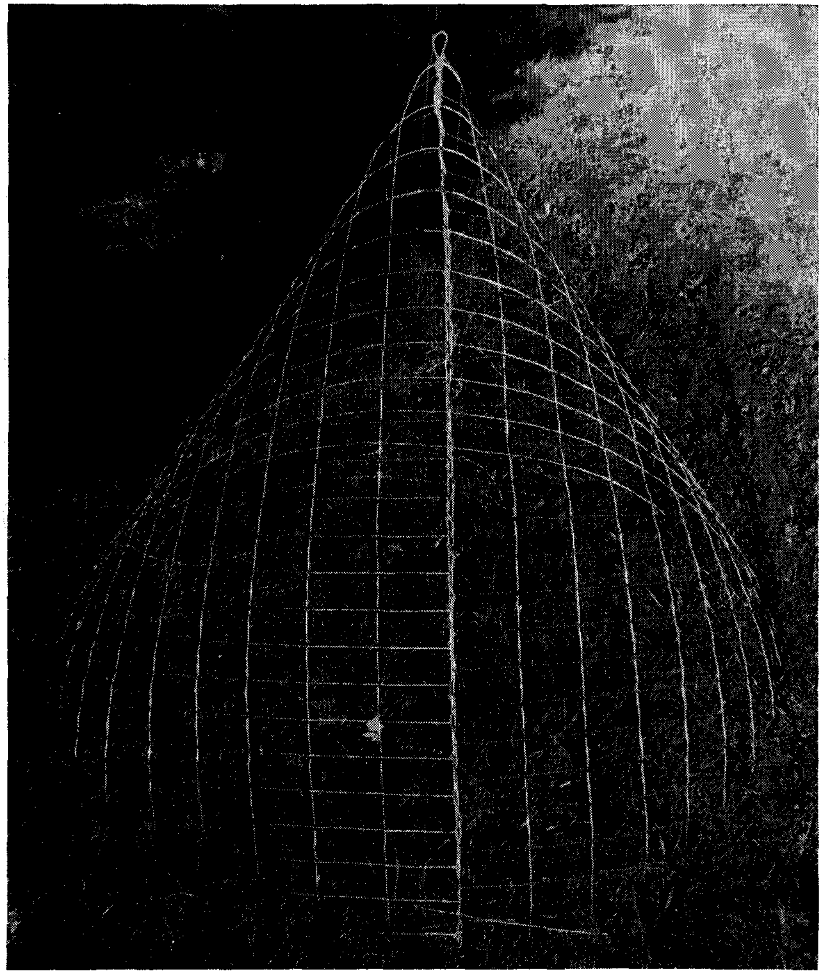

Figure 2. The "Cone Cage" in place.

of course, the key to making this method work. The pitfall of variation in density and composition is a dangerous one and techniques varying from random to personal selection were used to try and solve this problem.

Two methods appear to give the best reliability. One is selecting the three plot centers in the spring before vegetation has developed. At this time of year basal area of plants is readily visible and density can be judged fairly accurately.

However, we have found composition to be a very important criterion, and before forage development, plant identification can be extremely difficult. The other method is to select a comparable plot at the time of clipping. This is accomplished by throwing an object for plot center location, evaluating the density and composition for comparison; if representative, clip; if not, throw the object once again. Averaging the many transects on a given key area does tend to compensate for any gross error of an individual plot.

The problem of just what to clip also caused much concern. Undoubtedly, for best results, the plots should be clipped by species. However, it was realized if the method was adopted for statewide use, untrained field personnel would be involved and species identification could be a limiting factor. Also, after trying both techniques, the time element was found to be crucial when plots were clipped by species. A decision was made to clip only grasses, but no separation of species was attempted.

Clipping is attempted at ground level, and it is recommended that if two people are involved they clip each plot together rather than individually clipping protected and unprotected plots.

A common belief prior to this study was that the elements, wind and snow, were responsible for denuding large areas of vegetation during the winter months. This may be the case to a very limited extent, but surprisingly enough the residual stand of grass appeared to remain in place whenever protected from actual grazing.

One observation, made in an area that receives fairly light winter but heavy spring elk use, indicated that much of the old grass was knocked down by the trailing and spring feeding habits of elk. Despite high winds in this same section, the broken residual remained as valuable litter.

Results from the trial program using this technique indicated adequate separation between cattle and elk use could be made. Public acceptance of the findings now became the major goal.

To accomplish this, it was felt necessary that people should actually see for themselves the story told by these transects.

To fully evaluate the findings, two trips a year are necessary: one in the fall to compare total production and cattle utilization, and a return trip in the spring to observe the effects of elk use.

The reader may conclude this to be a disadvantage, for often it is difficult to get people out on the range once, let alone twice. It did, however, allow for the application of a little psychology.

Assume, if you will, the role of a cattleman who feels elk competition is responsible for the downward trend of forage production on his forest allotment. When would this range evaluation technique

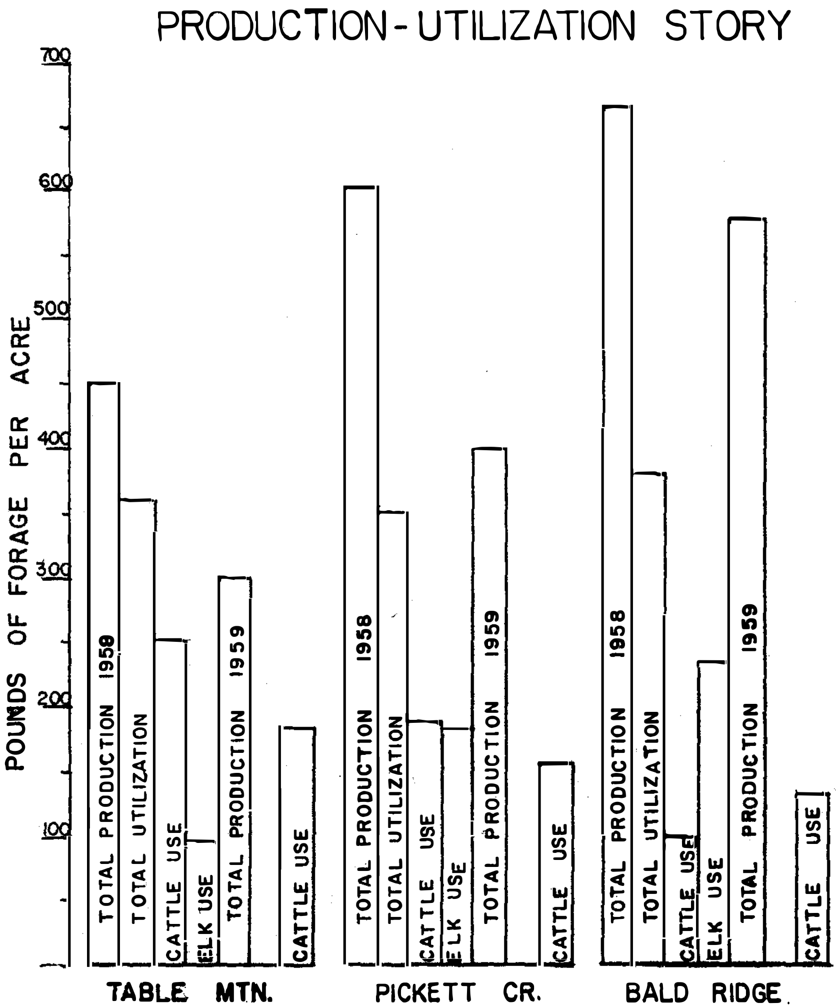

Figure 3.

appear more sensible to you? In the spring after elk use, of course, for you would see what you want to see. The reverse order would be used if you assume the role of a sportsman.

This then, "uncricket" as it may appear, was the procedure used to introduce our study program. The second half of the evaluation may not have appealed as well to the critics, but after accepting the technique in light of what they wanted to see, it was difficult to change their viewpoint because of the results.

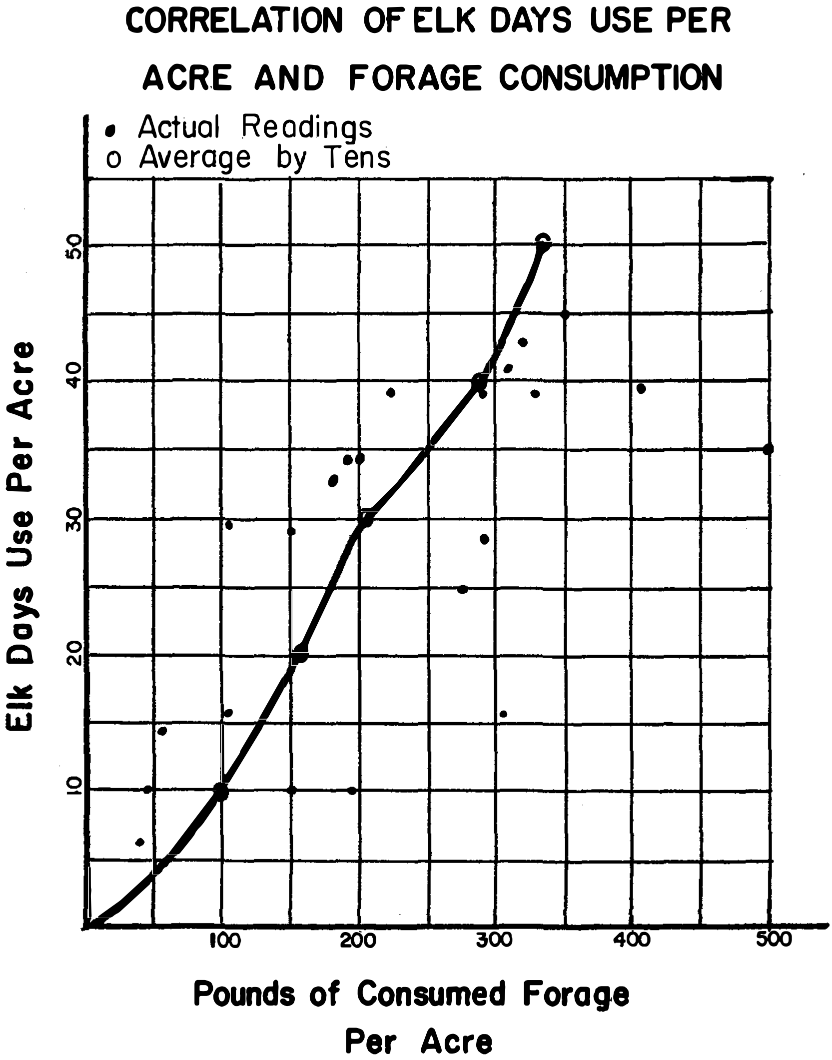

Figure 4.

It would be stretching the truth just a little to say everyone was happy or completely satisfied with the results. On the contrary, excuses of all kinds were formulated to justify the findings.

"Poor growing season."

"Bad water year."

"Unusual spring."

"Worst winter ever seen."

This type of thing was anticipated and believed of very little importance. But in our own minds, it was extremely rewarding that people had enough faith in the findings to necessitate this excuse making.

The reader may wonder just what information has been determined from these studies. Actually we have only completed one and one-half years' work so no trends in use have been established, but Figure 3 does tell the story in bar graph fashion of what use has been made on three areas during this limited time.

These three areas were selected to show all sides of the story, but as the reader can well interpret, red faces are now caused by embarrassment rather than heated argument.

As mentioned earlier, an attempt was planned to correlate elk days use per acre with pounds of forage removed. It will take a great deal more sampling and a statistical analysis before any conclusions can be drawn; however, the graph shown in Figure 4 indicates the findings thus far.

The obvious variance between individual readings is perhaps grounds enough to say the information is of no value. Yet, by averaging the forage consumed by animals grouped in the 1 to 10 elk days use per acre class, the 11 to 20 class, the 21 to 30 class, etc., a relatively smooth curve results.

It is probably human nature that each administrator dreams of a simple solution to range evaluation. The big shock comes when we realize range is not a simple subject. We must also remember that the selling job is by no means over with public acceptance of any one method, simple or complex. This is merely a "foot in the door" to the big problem of selling ourselves and our profession. We have to get people "smoking our brand." The day public acceptance is made of a game management principle because 9 out of 10 game managers employ it, we will be making real progress.

DISCUSSION

MR. ODELL JULANDER [Ogden, Utah]: You may recall that we used cages something like that, only circular in shape, for livestock. They just rubbed on them and scattered them all over the flat. Do they bother these cone-shaped ones?

MR. JONES: We didn't have any trouble with the wire. When we started out we were using a different type of wire with a 4inch mesh. Instead of being a welded fabric it was wrapped together, and we did have trouble then. Livestock did do a little rubbing.

We have had only one cage of this type completely destroyed. You could pick it up and it would almost dribble out of your hand. This was done by elk on an area when there were no cattle. I don't know if a bull elk got mad at it, but he really scattered it. Even the bottom of the cage had been dented in.

We recommend 11½-gauge wire, and if heavier gauge wire can be obtained, that it be used.

MR. JULANDER: The circular plot and the same kind of wire are favorite rubbing posts for cattle. On some areas elk would use the range in the spring as soon as the grass starts to grow. Now, if you had that kind of use, I don't know whether you did or not, it would be difficult to separate cattle use from elk use. Elk used it before the cattle came on to the area. Did you have any of that?

MR. JONES: Yes, that is something that I found no answer for in separating the spring use. However, in an area that we have no cattle use and only elk, we are going in this year before any production of spring grass and clip completely down to the level of the winter forage and put the cages on that. It will be more work. We would like to see if we can get information on the effect on the forage.

MR. JULANDER: In Utah one of our graduate students found that early deer use has a vital effect on grass. You may be interested in that.

On the location of your plots, since you used quite a bit of judgment in your selection, why not select them in the first place? I think you are not selecting them statistically anyway.

MR. JONES: That is very true, Dick. The only reason we go to any type of selection other than just going out and personally selecting is just a matter of public relations. I remember having one cattleman out when we were originally doing this by random selection. We asked him to throw the hoop, and it hit right over a big sage brush, and wasn't comparable at all to the plot we were clipping. However, if we had just gone out and actually made the selection without any type of randomization, you might say, well, it might not have gone over as well.

MR. GILBERT HUNTER [Colorado Game and Fish, Denver, Colorado]: You mentioned there was no significant difference observed between elk being on the range early and cattle. How about sheep? A few years ago we had a contention that our elk moved into the sheep range and seriously damaged the range prior to the entering of the sheep.

Have any of your studies covered the competition between sheep and elk in the high plateau country?

MR. JONES: No, they haven't, Gil. All of our studies so far have centered on elk winter ranges. That seems to be our only factor. I can only think of one area having sheep summering on them.

MR. HUNTER: The contention is that the elk come in on the sheep range prior to the sheep and damage the range. However, our studies did not prove that at all. I thought possibly you have something that might substantiate our claim.

MR. JONES: I have to go back a little to give anything on it at all—back to Utah. Dick has brought up something I was not aware of, so he might contradict me. We did have an exclosure put in on a reseeding area in the Mud Springs area in Salina drainage that despite some of the heaviest deer use I have ever seen on grass, the exclosure indicated, at least to us, that they are having little or no effect on total production. Whether Dick has found something other than that, I don't know.

We tried the same thing on alfalfa and there we did find a difference in the weight, because we were dealing with an irrigated species and although the deer would keep it down, once it was irrigated, it would grow fast and there would have been more succulence to it. When you air-dry weigh it, you lose poundage, but as far as observing the difference on the ground, you couldn't tell with the naked eye.

MR. SAMUEL H. LAMB [Santa Fe, New Mexico]: The point I didn't get was whether you moved these hurdle plots each year to different locations.

MR. JONES: A good point. We did move them after clipping to another site.

SEASONAL MOVEMENTS AND BREEDING BEHAVIOR OF SAGE GROUSE IN IDAHO[1]

PAUL D. DALKE, DUANE B. PYRAH[2], DON C. STANTON[3], JOHN E. CRAWFORD[4] AND EDWARD SCHLATTERER

Idaho Cooperative Wildlife Research Unit, Moscow, Idaho

The sage grouse *(Centrocercus urophasianus)* is one of the most important native upland game birds in the western United States on sagebrush-grass ranges. It occurs in 13 western states; and in Idaho, Colorado, Montana, Wyoming, and Nevada it is an important game species. The most important contribution to the life history and ecology of sage grouse was made by Patterson (1952) in an ecological study in western Wyoming. Sage grouse are not only well adapted to their sagebrush environment, but they maintain a highly specialized social structure during the breeding season. These specialized breeding activities provide one means of developing useful management techniques. The present field study began in 1952 with Research Fellow Pyrah, followed by Stanton, Crawford, and Schlatterer. The final phase on productivity is being completed in 1960.

OBJECTIVES

The objectives of this portion of the study were (1) to determine the behavior of strutting ground populations and associated reproductive phenomena, (2) to determine the extent of interstrutting ground movements, and (3) to determine the extent of seasonal movements.

STUDY AREA

An area in Jefferson, Clark, and Fremont counties, Idaho, approximately 50 by 50 miles, was selected to study seasonal movements (Figure 1). This area meets all of the year-round requirements of sage grouse. It is in a region of high sagebrush plains of gentle relief. Elevations vary from 5,000 feet at the southern end near St. Anthony to about 6,500 feet in the vicinity of Davis Lakes, 25 miles to the north. The area is bounded on the east by the foothills of the Yellowstone Plateau, on the north by the Centennial Mountains along the continental divide between Idaho and Montana, on the west by the Beaverhead and Lemhi Ranges, and on the south by the Snake River Plains. From the winter range west of Dubois at elevations of 4,700 to 6,300 feet to the summer brood range in Shotgun Valley the air-

---

[1]Contribution of the Idaho Cooperative Wildlife Research Unit; College of Forestry, University of Idaho; the Idaho Fish and Game Department; the Wildlife Management Institute, and the U. S. Fish and Wildlife Service, Bureau of Sport Fisheries and Wildlife, cooperating.
[2]Wyoming Game and Fish Department, Riverton, Wyoming.
[3]Maine Department of Inland Fisheries and Game, Sanford, Maine.
[4]Idaho Fish and Game Department, Idaho Falls, Idaho.

line distance is 35 to 75 miles. The strutting grounds which account for a portion of the population, and those studied intensively are approximately 20 airline miles southwest of the Shotgun Valley brood area. The Red Road strutting grounds lie between 5,000 and 6,000 feet elevation. The brood ranges are well watered and extend to the foot of the Centennial Mountains. Most of the study area is in the sagebrush-grass zone with little summer precipitation. Winters are severe. The snowpack in Shotgun Valley frequently reaches 5 to 7 feet and decreases to less than a foot west of Dubois. Summers are short with generally moderate days and cool nights. Lava forms the parent material for a large part of the area; lava outcrops are common, interspersed with shallow soils of lava derivation.

The vegetational cover is largely sagebrush (*Artemisia* spp.) with the most common form being big sagebrush (A. *tridentata*). Locally, black sage (A. *nova*) and (A. *arbuscula*) and three tipped sage (A. *tripartita*) are common. Bitterbrush *(Purshia tridentata)* and rabbitbrush (*Chrysothamnus* spp.) are associated with the sagebrush in many localities. Overgrazing and fire have replaced many perennials with annuals such as cheatgrass (*Bromus tectorum*) and Russian thistle (*Salsoli Kali* var. *tenuifolia*) and such undesirable shrubs as horsebrush *(Tetradymia canescens)*.

LAND USE

The area is a patchwork of private, state, and federal lands. Spring and fall grazing by sheep and cattle, particularly the former, is the principal economic use of the sagebrush lands. In Shotgun Valley and the Camas Meadows where irrigation water is available, alfalfa and cereal grains are grown. Some lands have been cleared of sagebrush and are being dry farmed where soil depth is sufficient to permit the use of modern machinery. Some of the potentially better grazing areas are being reclaimed by large-scale aerial spraying by the U. S. Forest Service and private interests. Where stream flow permits, some sagebrush lands have been converted to irrigated croplands. In the south-central portion is an area of approximately 30 square miles of sand dunes and stabilized dune sand. This is an important wintering ground for elk, moose and mule deer. These animals move 20 to 30 miles from the east and concentrate on portions of the sand area which supports extensive stands of bitterbrush and chokecherry *(Prunus virginiana* var. *demissa)*.

STRUTTING GROUNDS

A county road known locally as the Red Road winds in a northerly direction from near St. Anthony to the post office of Kilgore. Along

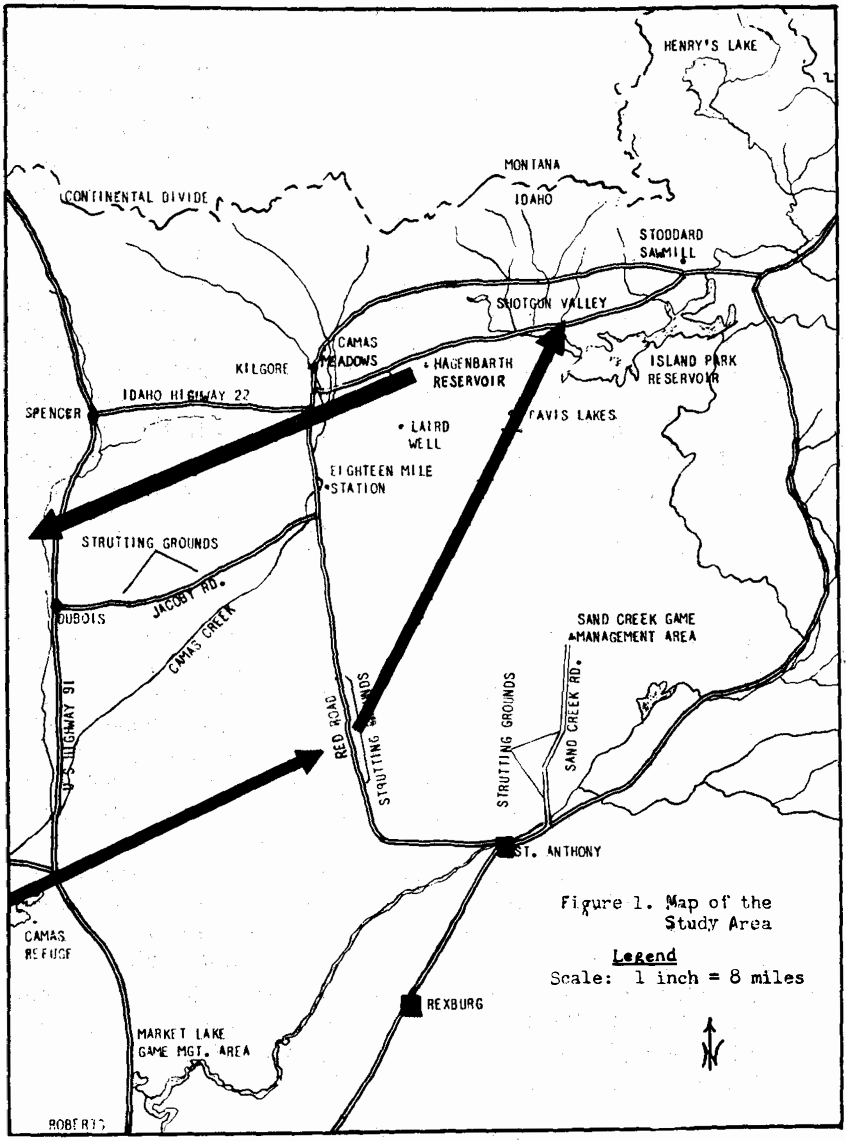

Figure 1. Map of the study area.

the lower 12 to 15 miles on either side of the road are located the strutting grounds and point of origin of this study.

A strutting ground is an area used by sage grouse for display and mating. The Red Road strutting grounds vary in size from one-tenth of an acre to 10 acres. They have exact locations and may be used for many years. During the seven years of the study, 19 strutting grounds were occupied along the Red Road. The larger grounds are always used, but some of the smaller grounds may be abandoned when the population is at a low ebb. In only three out of seven years, however, were all 19 grounds occupied.

The grounds range from 0.3 of a mile to 1.2 miles apart with distances up to 0.9 of a mile apart being the most common. A variety of situations are used as strutting grounds by sage grouse. The roadside sheep bedding grounds and old burns have created openings in the otherwise nearly solid cover of sagebrush. Sage grouse have taken advantage of these openings, and the concentrations of strutting grounds along the Red Road is one of three such concentrations within the over-all study area. The road itself is used as a strutting area on a few of the grounds. In such cases, the strutting birds are highly vulnerable to fast-moving vehicles and to poachers.

Rock outcrops are also used as strutting grounds. Sage grouse in the vicinity of Sand Creek game management area showed a preference for strutting sites associated with waterholes. Several grounds were located on grassy flats adjacent to open water.

BEHAVIOR PATTERN

Practically the entire population of adult and subadult sage grouse gather on strutting grounds for courtship displays and mating performances. Strutting grounds have primary mating spots, and here will be found the largest number of birds on any one ground at any one time.

Each strutting ground exhibits a considerable variation in numbers of grouse from the time the first adult males appear until the ground is abandoned. Because of this variation in numbers it is important that as many grouse as possible be marked on each ground to determine the extent of interground movement. The fluctuating numbers of males on these grounds suggest interground movement, or absence for other, but unknown, reasons.

Figure 2 illustrates the general pattern of attendance of adult males, subadult males, and females on ten major strutting grounds located along the Red Road. The adult male population increases rapidly during late March and early April, indicating the general movement taking place at this time. Following the period of buildup,

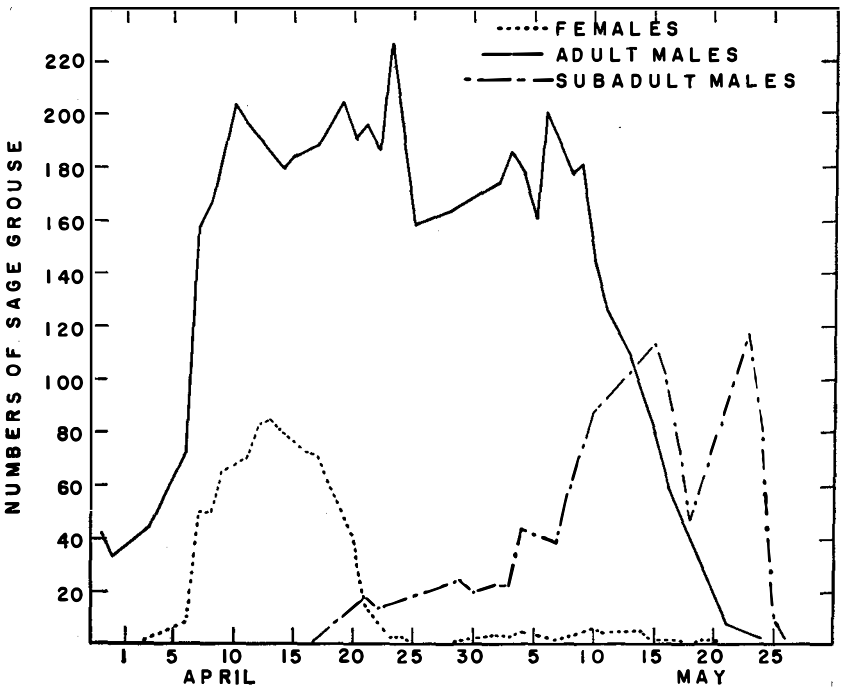

Figure 2. Composite Red Road strutting ground attendance, 1956.

some grounds display a period of instability in numbers of adult males which persisits until after the peak of mating activities. Although the daily fluctuations are marked, the general pattern shows a high concentration of males. As the breeding season advances and adult male numbers drop off, the subadult males appear in larger numbers. Often the last sage grouse observed on strutting grounds are the subadult males.

The pattern of female attendance of the strutting grounds is one of rapid buildup. The two-week period between April 7 and 21 is the critical mating period. In most years after April 21 the numbers of females appearing on the grounds were less than 10 per cent of their maximum numbers. On a number of grounds, females disappeared for nearly a week and then reappeared in small numbers for several days to a week. The status of these females was not determined, though many of them may have had their nests destroyed. In western Wyoming, Patterson (1952) found that 57 per cent and 23 per cent respectively of the nests on two different areas were destroyed. The three most common types of nest predators in the Wyoming study, namely the badger, ground squirrel, and magpie, are also present on the Red Road portion of the study area.

The greatest success of trapping and banding on the strutting grounds occurred at the peak of the mating period since the presence of the hens tended to concentrate the males. During this period the strutting grounds contain a number of social orders (Scott, 1942). The central and dominant birds are the master cocks who occupy the primary mating spots as well as defending a larger territory. Surrounding the master cocks are other adult males known as subcocks, and on the periphery are still other adult males lower on the social order called guard cocks. Most of the mating is done by the master cocks, a small amount by the subcocks, and a very minor percentage by the guard cocks.

The territory defended by the master cocks rarely exceeded an area 40 feet in diameter while the primary mating spots were only about 5 feet in diameter.

Adult males attending any one strutting ground fluctuated from year to year. On the well established grounds the differences were as little as 33 per cent and as great as 250 per cent above and below the mean numbers from 1953 to 1959 inclusive.

The ratio of males to females is highly variable from day to day, even during the two-week period when maximum numbers of hens were present. The observed sex ratio based upon 18,316 observations is shown in Table 1. These observations cover the period of peak mating and subsequent time to strutting ground abandonment.

TABLE 1. OBSERVED SEX RATIOS OF SAGE GROUSE, RED ROAD STRUTTING GROUNDS, 1956-1959 INCL.

Year	April 7-21	April 22-May 25	No. of Observations
1956	276 males : 100 females	593 males : 100 females	7,200
1957	292 males : 100 females	No data	2,450
1958	183 males : 100 females	216 males : 100 females	4,033
1959	300 males : 100 females	323 males : 100 females	4,633

Sex ratios obtained from sage grouse examined at checking stations were sharply in contrast to those determined while the birds were assembled on the strutting grounds. Table 2 shows the sex ratios during 1956, 1957, and 1958 from grouse shot in eastern Idaho, some of them out of the same population which bred on the Red Road and adjacent strutting grounds (Salter 1957, 1959; Bizeau, 1959).

TABLE 2. SAGE GROUSE SEX RATIOS, DISTRICT 5 CHECKING STATION RECORDS, 1956-1958 INCL.

Year	Males		Females	Sample Size
1956	70	:	100	3,147
1957	88	:	100	3,045
1958	92	:	100	3,888

TRAPPING AND BANDING ON STRUTTING GROUNDS

Two cotton nets, 25 by 75 feet, were used during the early part of the investigation. A nylon net, 50 by 100 feet, was added during the last three trapping seasons. Both the electrical lead-wire and the radio-controlled firing devices were used. Both types of firing mechanisms proved effective when applied to specialized situations. The electrical lead-wire was simpler with fewer mechanical complications. It was especially effective when used with more than two nets as additional power was then required over the radio-unit's six volt limit. The radio unit was valuable in situations where distance between the trap site and firing point was too great for practical use of wire. The radio unit also provided considerable mobility for the trapper, and upon occasion it was possible to drive sage grouse into range of the net. Some adult males, during the peak of mating activity, returned to their accustomed places on the strutting ground within an hour after having been trapped and marked. Captured birds generally flew 200 to 500 yards after marking. Some cock birds refused to fly at all, but ran away into the sagebrush.

INTERSTRUTTING GROUND MOVEMENTS

Grouse were trapped and marked on their Red Road strutting grounds for five years, totalling 379 birds divided by sex and age as follows:

	Adult		Subadult			
Year	Male	Female	Male	Female	Total	Trapping Period
1953	17	7	2	7	33	April 13-May 20
1956	28	13	15	11	67	April 4-May 19
1957	10	5	1	3	19	April 12-April 19
1958	33	16	12	15	76	April 9-May 8
1959	58	49	22	55	184	April 4-May 15
Totals	146	90	52	91	379	

A modification of the jesse knot of one-half inch plasticised polyvinyl chloride tape was used in color combinations to identify the birds from each strutting ground for each of the five years. Any initial concern that trapping and marking would have a deleterious effect on the sage grouse was unfounded, for normal strutting behavior continued throughout the trapping season as long as the hens were on the grounds. Efforts to trap the same grounds each day actually yielded fewer birds than an every other day or every third day schedule. A slight shifting of primary mating spots after traps had been set sometimes resulted in only one or two trapped birds.

Seventy per cent of the banded grouse returning the first, second, and third years were seen on the strutting grounds where they were first trapped and on no other strutting grounds. Some master cocks occupied almost identical places for two successive years. Other master cocks were relegated to a lower status in the social order in the succeeding year. There was a greater tendency for males to return to the same strutting ground than for females, who exhibited no territoriality.

Seven percent of the 1956 banded grouse of both sexes returning in 1957 were involved in interstrutting ground movement. Similarly, 5 percent of the 1957 marked grouse returning in 1958 and 18 percent of the 1958 marked grouse returning in 1959 were observed on other grounds. Trend-count figures are reliable where the entire complex of strutting grounds is used instead of trend counts for the individual strutting grounds.

Interground movements of grouse returning a year after trapping ranged from 0.3 of a mile to 3.3 miles, averaging 1.1 miles. Similar movements of grouse returning the second years varied as much and averaged 1.5 miles. Since only about 10 percent of the spring population is involved in any apparent movement from one strutting ground to another, the population can be considered as having a strong homing instinct. The interground movement, mostly by males, continued well past the peak of mating; and subadult males account for much of this late breeding season movement.

SUMMER MOVEMENTS

Sage grouse are normally gregarious excepting females during the laying, incubating, and early brooding periods. Adult males and nonproductive females spent most of the summer in small, sexually segregated flocks.

Large numbers of hens with broods appeared in Shotgun Valley and Camas Meadows about July 1. Some of these hens were marked on the Red Road strutting grounds, 15-20 miles to the south and west; others came from the Sand Creek strutting grounds, 12 miles east of the Red Road, and the Jacoby Road grounds, 16 miles northwest of the Red Road.

By late July or early August the brood structure began to deteriorate. Composite broods with two or three hens were commonly observed, until by late August, 30 to 50 juveniles with a few old hens may be seen. Most of the sage grouse are still on their summer range at the time of the hunting season in September, and band recoveries showed a maximum distance of 25 airline miles travelled from the Red Road marking site.

FALL AND WINTER MOVEMENTS

By mid-September initial fall movements were observed from Shotgun Valley. Migration began in earnest when temperatures had dropped to 15 and 20° F. Large flocks began to appear at waterholes along the migration routes. There was considerable walking, but as the fall advanced flights of grouse up to 5 miles were observed from October to mid-December, all in a southwesterly to westerly direction. By late October sage grouse were scarce on the summer range.

Girard (1937) and Patterson (1952) found Wyoming sage grouse occupying ranges at lower elevations in winter and higher elevations during the summer and in most years travelling 50 to 100 miles from summer to winter ranges. Migrations from Shotgun Valley to winter ranges 30 to 75 miles west and southwest were similar to those described by Patterson.

Wintering concentrations were variable and are influenced depending upon the severity of the weather; during the coldest weather the concentrations were the largest. Sagebrush fulfills all of the winter requirements for both food and shelter. Black sage was used as long as the snow was only 3 to 6 inches deep. When as much as 10 inches covered the short sage, the grouse left these areas but returned during mild weather when the black sage was again exposed.

Flocks on the winter range numbered from 10 to approximately one thousand. The wintering concentrations were loose associations composed of small groups of 5 to 100 birds. Old males continued in small flocks, usually fewer than twelve. Smaller flocks often joined other flocks to form large roosting groups. They frequently roosted on high, rocky sites with heavy sagebrush cover. During late February small groups of sage grouse were seen making their way in the direction of the Red Road strutting grounds, where the annual breeding activities take place for a good share of the population concerned in this study.

By late March flocks were again observed in the vicinity of the Red Road in numbers exceeding one hundred. Local distribution at this time was largely limited to areas free or nearly free of snow. Thus, by April 1 the Red Road population had travelled from 150 to 200 miles for the round trip.

MANAGEMENT TOOLS

The high count of males for any one strutting ground or a series of closely related grounds has been used as a management tool in Idaho for about ten years. Thus, trends in the breeding population over the entire sage grouse range in Idaho have been followed. Because of the size of the range, numbers of strutting grounds, and personnel limitations, individual or closely related grounds have been counted only three times during the two-week period when the highest numbers of males visited the strutting grounds. In the present study, counts were made up to 10 times during similar periods. In only one year out of five did population estimates from the intensive count exceed the three-day count, which adds validity to the shorter method as long as present management methods remain extensive rather than intensive

While it is important to know population trends from year to year, the game manager is faced with forecasting the annual crop of sage grouse and other game birds. The present study illustrates how strutting ground trends alone may lead a game manager astray in evaluating the yearly production because of conditions which exist after the grouse have left the strutting grounds.

Sage grouse are highly vulnerable to adverse weather conditions during and immediately following the hatching period. The events taking place during the 1959 nesting and brooding periods illustrated conditions encountered only once during the investigation, but were of such magnitude to alternately fill the game manager with high hopes and then despair. We cite the following experience as an example of the kinds of extremes which may be expected in managing sage grouse under the conditions existing in southeastern Idaho and in similar high plains country.

In 1959 sage grouse returned to the Red Road strutting ground complex in the largest numbers since the first strutting ground counts were made in 1952. Forty-seven percent more grouse were trapped on the strutting grounds and 26 per cent more males were counted than in any other year. The observed peak of hatch (75 per cent) based upon brood observations, compared to known aged chicks, occurred between May 18 and June 3. During this period there were 9 days of cold rain, snow, and high winds, and 7 days with minimum temperatures below freezing. Maximum temperatures were below 65° F., and for 8 days temperatures were between 50 and 60° F. Subsequent counts on three brood routes showed a decline in numbers of broods by late July of 26 percent, and reduction in average size of each brood of 19 per cent over 1958. The Shotgun Valley brood route, which had 54 per cent of all the broods of the three brood routes, showed 2.3 birds per mile, the lowest in 4 years. In 1958 this brood route showed 4.3 birds per mile, the highest of the 5 years. For management purposes, the size of the crop must be determined as early in the summer as possible in order to establish regulations for the hunting season, which is usually between September 15 and 20. Since the decline in brood size after July 15 is usually only from 4 to 8 per cent, a general forecast can be made at that time.

As management practices are intensified, and with increased numbers of hunters, and reduction in sagebrush habitat, the forecast of the annual crop of sage grouse becomes one of the most important objectives of the game manager.

SUMMARY

A study of seasonal movements and strutting ground behavior of sage grouse was undertaken by the Idaho Cooperative Wildlife Research Unit in 1952 in an area comprising parts of three counties in southeastern Idaho directly west of Yellowstone National Park.

The study area is mostly high sagebrush plains with scattered irrigated farming, and livestock grazing is the principal use of the sagebrush-grass lands. Sage grouse travel 50 to 100 miles from the summer range, westerly and southwesterly, to winter ranges which have only 3 to 6 inches of snow for short periods.

Adult males arrive on their strutting grounds on the Red Road area north of St. Anthony during late March while snow is still on the ground. The breeding population is at a maximum on the Red Road strutting grounds from April 7 to 21 during most years.

Marking of males and females show movements up to 3.3 miles. Females are more likely to move to other strutting grounds than males.

The annual high-count of males on strutting grounds is a useful population-trend tool, but may, in some years, fail to provide the game manager with the means of forecasting the annual crop of sage grouse in some areas. The numbers of grouse returning to the strutting grounds in 1959 indicated a high yield of subadult birds. Adverse weather conditions at the time when 75 per cent of the eggs were hatching resulted in the lowest population of young birds in the seven years of the study.

Brood-count routes at least 20 miles in length give reliable results until about July 30; however, there is only a small decline in average brood size after July 15. By the third week in July information is available for reliable forecasting of the annual crop of sage grouse which will be available to hunters in the September hunting season.

LITERATURE CITED

Bizeau, Elwood
1960. Statewide game bird survey and investigation. Harvest information-1958. Idaho Department of Fish and Game. 66 pp.

Girard, George L.
1937. Life history, habits, and food of the sage grouse (*Centrocercus urophasianus* Bonaparte). Univ. of Wyo. Publications 3(1):1-56.

Patterson, Robert L.
1952. The sage grouse in Wyoming. Wyoming Game and Fish Comm. 341 pp.

Salter, Robert L.
1957. Statewide game bird survey and investigation. Project W 96-R-7 Job D. Harvest information 3/1/56 to 2/28/57. Idaho Department of Fish and Game. Federal Aid in wildlife restoration.
1959. Statewide game bird survey and investigation. Project W 96-R-8 Job C. Harvest information, 3/1/57 to 2/28/58. Idaho Department of Fish and Game. Federal Aid in wildlife restoration.

Scott, John W.
1942. Mating behavior of the sage grouse. The Auk 59(10):477-498.

DISCUSSION

DISCUSSION LEADER ADAMS: What is this discrepancy between the sex ratio at the strutting ground and in the hunter bag? How do you account for the fact that they are so different?

DR. DALKE: Certainly there are many birds that come to the edge of these strutting grounds, and yet they are out far enough in the sage brush that they cannot be counted accurately. It would be impossible to sex them.

MR. SAMUEL H. LAMB [Santa Fe, New Mexico]: Dr. Dalke, have you ever tried locating new strutting grounds from the air?

DR. DALKE: We haven't done that in this study, but the Idaho Fish and Game Department has located many grounds through aerial survey.

DR. R. E. TRIPPENSEE [University of Massachusetts]: Were aerial photographs used to locate strutting grounds?

DR. DALKE: We didn't use any. In fact, we were not surveying the area to locate strutting grounds, but they certainly can be located.

DR. TRIPPENSEE: Do you think they could be used for that?

DR. DALKE: Yes.

BROWSING AND STAND REGENERATION IN CLEAR- AND SELECTIVELY-CUT HARDWOODS

THOMAS H. RIPLEY AND ROBERT A. CAMPBELL

Southeastern Forest Experiment Station, U. S. Forest Service, Asheville, N. C.

The concept that timber and wildlife resources cannot be managed simultaneously to the mutual advantage of both is rarely heard today. In recent years clear recognition of the need for multiple-use management has been emphasized. Accompanying this recognition has been an awakening by forest land managers to research needs to place multiple resource management on a sound and progressive basis.

The presence of deer in hardwood forests offers great opportunity for valuable hunting recreation, but the species often creates serious problems in stand management. In overpopulated deer range the establishment of satisfactory tree reproduction—both in stand composition and stocking density—is often difficult, if not impossible, using current selective cutting methods. Using exclosures in numerous locations in the southern Appalachians, regeneration deficiencies have been observed. Deer have a taste for browse that frequently includes reproduction of valuable timber species. Yellow-poplar is especially palatable, and a species which is often difficult to regenerate if deer are numerous.

Ruff[1] found that the whitetail in the Pisgah National Forest of North Carolina did not yard the way more northern populations do; instead, he found that deer tend to congregate in coves and lower

[1]Ruff, F. V. The white-tail deer on the Pisgah National Game Preserve, North Carolina. U. S. Dept. Agr. Forest Serv. Unpub. report of research covering 6 years of intensive investigation. 1938.

slopes during the winter. These areas frequented by deer also constitute the more important timber-producing sites. Cove and north slope sites are characterized by deeper, more moist and fertile soils with notably higher site potentials that favor growth of yellow-poplar and other important timber species (Renshaw and Doolittle, 1958).

THE ORIGINAL STUDY

Morriss (1954), working with the North Carolina Wildlife Resources Commission, started the study on the Pisgah Ranger District of the Pisgah National Forest in 1949. The objectives were to assess the effect of cutting intensity on the production and utilization of deer browse, and, secondarily, to study the establishment and survival of tree and shrub reproduction. Three unreplicated treatments were imposed as follows:

"*Area I*—Clearcut. 70 acres. Four to six seed trees per acre were left. All other sawtimber was cut in the commercial operation. All stems remaining were cut by a state crew using Pittman-Robertson funds. Cost was $42.82 per acre.

"*Area II*—Modified Clearcut. 84 acres. The cut was the same as for Area I except that smaller stems that contained or would produce shuttle blocks, posts, pulp, or sawtimber were left. Cost was $16.33 per acre.

"*Area III*—Improvement Cut. 84 acres. A commercial saw log cut was made followed by a regular T.S.I. The condition of the timber required a sanitation and species improvement cut that was equivalent to heavy group selection. There were no direct wildlife costs to Pittman-Robertson funds.

"Commercial cutting was done in the summer of 1949, and Pittman-Robertson cutting on Areas I and II in the spring of 1950."

All areas had topography ranging from high cove to ridge top, and all had a general eastern to northern exposure. Elevations ranged from 3,100 to 3,700 feet. Conditions prior to treatment presumably were comparable in the three areas.

Two years after treatment, 80 milacre quadrats were used to measure regeneration on each treatment area. These data were published by Morriss (1954), and his tabulation is reproduced in this paper (Table 1). No species breakdowns were shown, but the results were unquestionably important. Attention should be given to the numbers of seedling stems of all species under three feet in height, and the number of sprouts both under and over three feet in height. These figures are important to the thesis that is developed in subsequent discussions.

TABLE 1. REPRODUCTION ON THREE LEVELS OF CUTTING[1]

Height and origin of stems	Stems per acre, all species			Stems per acre, browse species only		
	Area I	Area II	Area III	Area I	Area II	Area III
	Number			Number		
Under 3 feet in height						
Sprouts	6,857	9,362	3,000	4,737	6,550	2,000
Seedlings	13,775	7,287	10,321	2,850	4,450	6,357
Sub-total	20,632	16,649	13,321	7,587	11,000	8,357
Over 3 feet in height						
Sprouts	3,812	475	179	3,000	437	155
Seedlings	212	50	107	25	25	107
Sub-total	4,024	525	286	3,025	462	262
Total	24,636	17,174	13,607	10,612	11,462	8,619

[1]Reproduced from Morriss (1954).

REAPPRAISAL

In 1959, ten years after treatment, conditions were reappraised in the treated areas, using 1/100-acre circular plots to sample regeneration. Twenty, twenty-six, and thirty plots were measured in the clear-cut, modified clear-cut, and improvement-cut areas, respectively. The number of stems of tree reproduction one-half inch d.b.h. or larger on each sample plot were tallied by species and origin of regeneration; *i.e.,* seedlings, single stem sprouts of below- and above-ground origin, and multiple stem sprouts with below- and above-ground origin. In addition, the degree of browsing at each plot was noted (light, moderate, heavy, or very heavy). Important browse species, such as *Cornus florida* and *Smilax rotundifolia* were used in making these observations.

Because of our inability to reconstruct—to our satisfaction—the nature of the original treatment in the ''Modified clear-cut'' area, we have confined tabular presentations, analyses, and discussions to the clear-cut and improvement-cut treatments. Because the original data collections were confined to treated areas, we saw no advantage in sampling uncut areas in this appraisal. In effect, the ''Improvement cut'' constituted a normal, selective forest operation, or control, and the ''clear cut'' an experimental treatment.

Statistical analyses of the data were limited to significance tests involving seedlings and single stem sprouts with below-ground origin. This limitation was imposed so that analyses would deal only with regeneration which had reasonable assurance of producing sound crop trees. Numbers of stems of commercially important species were compared by calculating ''t'' and assuming measurable difference would be caused by treatment. A comparison of stand composition for major commercial species between the two treatment areas was made by chi square analysis—again assuming that demonstrable difference, if it existed, would be the result of treatment. Had total stem counts been used for comparison, differences would have been considerably greater, but probably less realistic. In addition, the percentage frequency of occurrence of important timber species was determined for total plots sampled. This was done to appraise distribution patterns of regenerating seedlings and sprouts as these might bear on the ultimate stand produced. No statistical treatments, however, were imposed on these data.

RESULTS OF REAPPRAISAL

Figure 1 shows the results of tallies taken 10 years after treatment in the clear-cut and improvement-cut areas. Yellow-poplar seedlings and single stem sprouts with below-ground origin had a significantly higher density, with 190 stems per acre in the clear-cut area, in contrast to the 43 stems per acre in the improvement-cut area. Regeneration of yellow-poplar, northern red oak, white oak, and chestnut oak together was significantly higher in the clear-cut area (255) than in the improvement-cut area (76). The difference in the number of stems of desirable origin for all commercial species between treatments (490 and 149) was highly significant. In addition to stem counts shown in Figure 1, totals for seedlings and all coppice growth (desirable and undesirable origin and all species) were 1,170 and 239 in the clear-cut and improvement-cut areas, respectively.

Figure 1 gives the percentage frequency occurrence of important timber species and species groups for total plots sampled by treatment and origin. These data show that the spatial distribution of regeneration is much more uniform in the clear-cut area. Seedlings or some type of coppice growth were tallied in all plots in the clear-cut area. In contrast, regeneration of any type was recorded in only 50 percent of the plots in the improvement-cut area. In the improvement-cut area yellow-poplar was tallied on 5 of 30 plots (17 percent) where it was classed as having "Desirable origin," and on only 3 of 30 plots (10 percent) where it occurred from "Undesirable origin." Here its occurrence was recorded on plots that fell in heavy slash areas where numerous sprouts were afforded substantial protection from browsing.

Tabulated stem counts suggested an important difference in the composition of commercially important species between treatments. Using the improvement-cut data as expected values, a significant chi square value was calculated. Yellow-poplar, chestnut oak, white oak, and northern red oak, collectively, exerted the major influence on differing composition, and it appeared that clear cutting favored stand composition by increasing percentages of yellow-poplar and

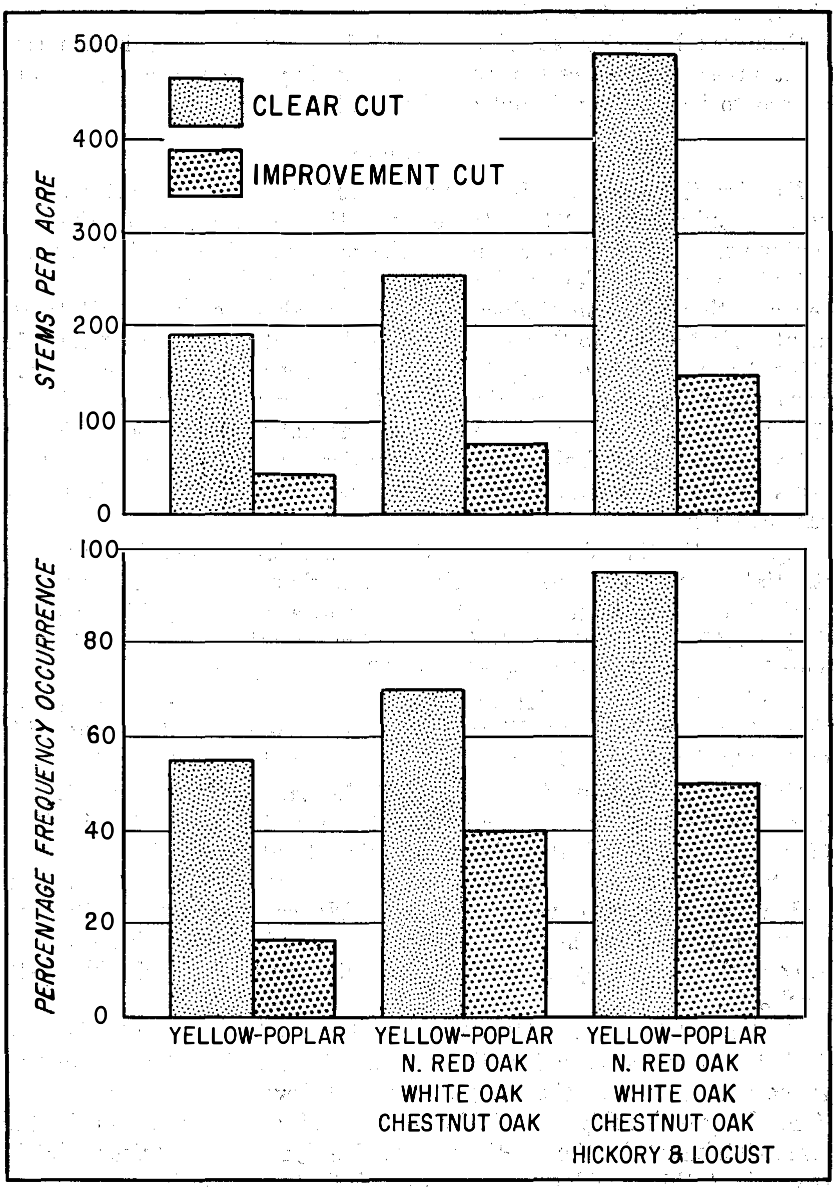

Figure 1. Stems per acre and percentage frequency of occurrence in sample plots of commercial species of desirable origin by treatment.

white oak. While small, the percentages of northern red oak and chestnut oak were larger in the improvement-cut area.

Observed browsing activity suggested heavy usage in both treatment areas at the present time, but the improvement-cut area appeared to be severely, if not overly, used.

DISCUSSION

Morriss (1954) concluded from his data that two important phenomena existed: (1) "that the cleaner the cut, the greater the percentage of sprout regeneration and the sooner the browse should grow out of the reach of the deer"; and (2) that usable browse (including reproduction of some timber species) was about equal in all treatments. He found also that usage in the clear-cut area dropped sharply after 2 years, and concluded that the density of regrowth may have adversely affected deer feeding activities. Morriss also reasoned that if the production of excessive browse was not used by deer, a heavy cut would be inadvisable. The reappraisal suggested, however, that excessive browse production may be important to insure satisfactory regeneration.

Apparently the 70-acre clear-cut area was large enough for a substantial surplus of browse to develop, perhaps larger than needed. Both size and configuration of treated areas are factors of importance that would merit future study. Greater succulence of sprouts also may have contributed to resulting differences. In the clear-cut area, where browse was abundant, deer may have favored sprout reproduction, thus permitting seedling development. We cannot support this with data, but it would appear to be a contributing factor.

Unfortunately, there is no record of the amount of browse utilized in either the improvement or clear-cut areas. Data collected in 1949 (Morriss, 1954) and 1959 indicated that total quantities of woody vegetation were much higher in the clear-cut area, and that this area had a much better developing stand. We concluded that although browse produced in the clear-cut area was used heavily, there was an excess which actually favored the development of a valuable well-stocked stand.

Curtis and Rushmore (1958) found that small openings in Adirondack forests were very heavily used by deer, and that this use had an adverse effect on the composition and development of reproduction. Unquestionably, small clear-cut openings would result in the same detriment in the southern Appalachian areas. Bulfer (1954) recognized this problem and suggested that cutting be deferred in Wisconsin areas until herd reduction could be effected that would permit satisfactory regeneration after cutting. On the other hand, Gysel (1957) found, and defended by discussion with Frankenburger (1958), that clear cutting oak-aspen types in northern Michigan produced more browse than deer could consume. He used larger areas, however, than Curtis and Rushmore. Gysel concluded that browsing actually resulted in no detriment to developing stands of aspen and may have been silviculturally beneficial. A marked parallel between Gysel's work in Michigan and this study on the Pisgah is apparent.

Clear cutting is not always a feasible harvest operation. From strictly a timber standpoint it is probable that some cutting intensity short of clear cutting would be more practical, economically, and still result in satisfactory reproduction. Increased wildlife benefits could, however, call for heavier cutting. Swift (1953) and Morriss (1954) have shown that coordinated effort between game workers and forest managers can produce desired levels of cutting intensity for multiple-use purposes.

Other resources may demand even greater consideration than timber and wildlife in certain areas of the Appalachians. Water is a resource of great importance. Kovner's work (1956) at the Coweeta Hydrologic Laboratory in the southern Appalachians demonstrated that clear cutting a watershed without removal of felled material actually increased yield without reducing water quality. It is doubtful if careful logging of clear-cut areas would necessarily impair the water resources. Where trout production is important, care should be exercised not to elevate stream temperatures beyond safe limits. Aesthetically, clear cutting may be undesirable. Here, marginal strips of uncut timber might alleviate the problem in important scenic areas adjacent to roads.

We suspect that a heavy recutting of the original clear-cut sites might rejuvenate browse production while simultaneously releasing desirable regeneration from the competitive influence of undesirable coppice—when developing seedling and single stem sprouts are beyond the reach of deer. Accordingly, a follow-up study has been imposed in the area to test these hypotheses.

Our findings suggest that clear cutting fairly large blocks of southern Appalachian mixed hardwoods may actually be extremely beneficial to several resources concurrently. The original study and the reappraisal, however, were conducted without treatment replication, and many important interim data are lacking for thorough ecological interpretation. Periodic measurements for browse production and utilization are an obvious deficiency. In short, additional research would yield extremely valuable results for effective multiple-use management.

SUMMARY

Two tracts of typical mountain hardwoods (70 and 84 acres) on the Pisgah National Forest were clear and selectively cut in 1949 to observe browse production-utilization and regeneration of seedlings and coppice growth. Since the installation of treatments the Forest has supported relatively high deer populations.

Two years after cutting (1951) the total number of seedlings and single stem sprouts on the clear-cut area was approximately twice that of the selectively-cut area. This first appraisal also indicated substantially lower utilization of browse in the clear-cut area.

Ten years after treatment (1959) the stands were remeasured to appraise changes in browse and regeneration conditions in the developing seedling and coppice stands. On the selectively-cut area the stocking of commercially valuable seedlings and single stem sprouts was less than a third that of the clear-cut area. A significant difference was found in composition of the regenerating stands—in the main, more favorable in the clear-cut area. Yellow-poplar, a favored browse species, occurred with a significantly higher number of stems per acre in the clear-cut area than in the selectively-cut area (190 and 43 stems, respectively). Similarly, total reproduction of other valuable timber species of desirable origin was significantly more abundant in the clear-cut area (490 vs. 149). Although moderately heavy browsing was evident in the clear-cut area, the selectively-cut area appeared to be severely, if not overly, used.

All facets of the data tend to support the thesis that more browse was produced in the clear-cut area than could be consumed by deer—thus permitting the establishment of satisfactory regeneration. The relatively large size of the area and succulence of coppice regeneration may have been factors that contributed to the differences observed. While additional research is clearly needed, the data suggest that clear cutting may offer an opportunity of enhancing timber and deer resources simultaneously.

LITERATURE CITED

Bulfer, D. E.
1954. The Wisconsin cooperative forest wildlife program: the foresters' viewpoint. Soc. Amer. Foresters Proc. 1954:138-141.

Curtis, R. O., and Rushmore, F. M.
1958. Some effects of stand density and deer browsing on reproduction in an Adirondack hardwood stand. Jour. Forestry 56:116-121.

Frankenburger, R. S., and Gysel, L. W.
1958. Comments on "Effects of silvicultural practices on wildlife food and cover in oak and aspen types in northern Michigan." Jour. Forestry 56:433.

Gysel, L. W.
1957. Effects of silvicultural practices on wildlife food and cover in oak and aspen types in northern Michigan. Jour. Forestry 55:803-809.

Kovner, J. L.
1956. Evapotranspiration and water yields following forest cutting and natural regrowth. Soc. Amer. Foresters Proc. 1956:106-110.

Morriss, D. J.
1954. Correlation of wildlife management with other uses on the Pisgah National Forest. Jour. Forestry 52:419-422.
Renshaw, J. F., and Doolittle, W. T.
1958. Silvical characteristics of yellow-poplar. U. S. Forest Serv. Southeast. Forest Expt. Sta. Paper 89.
Swift, E.
1953. Modifications of forest practices in the Lake States for wildlife habitat betterment. Jour. Forestry 51:440-443.

DISCUSSION

DISCUSSION LEADER ADAMS: We can take off our hats to the pioneering efforts of the people in the South and southwestern states in this work to relate forest management to deer management.

MR. FRANK BARRICK [Raleigh, North Carolina]: Tom, did you gain any insight as to the possible relationship between length of cutting cycles on clear-cut as compared to partially cut areas? In other words, is there a significant difference as to how soon you could make a commercial cut on one area as compared with the other type of operation?

MR. RIPLEY: Certainly cutting would be more frequent with selective harvest, but in a seed-tree cut, perhaps shorter rotations are indicated. Perhaps, if cutting were based on a seed-tree or clear-cutting basis, on a definite rotation so that certain acreage of operable timber stands were cut every year, this would seem to us to tend to stabilize available forage for deer, which is not the case where we are cutting our stands selectively, but I think you would cut more frequently in the improvement-cut areas.

RECENT ADVANCES IN FIELD IMMOBILIZATION OF LARGE MAMMALS WITH DRUGS

HELMUT K. BUECHNER, A. M. HARTHOORN, AND JOHN A. LOCK
Department of Zoology, Washington State University, Pullman, Washington; Department of Veterinary Physiology and Department of Pharmacology, Makerere College, Kampala, Uganda

Since publication by Hall, *et al.* (1953) and Crockford, *et al.* (1957a,b) of practical techniques for immobilizing white-tailed deer, unpublished reports on application of the technique to several species of large wild ungulates have indicated unfavorable results. Often animals were either killed with too much of the paralyzing drug (usually nicotine alkaloid) or they failed to become immobilized because insufficient amounts of the drug were administered, and there was much dissatisfaction with the performance of the automatic projectile syringe (Crockford, *et al.*, 1958) used to deliver the drug and the Cap-Chur[1] gun with its limited range of 40 yards. Within the past year, improvements in field techniques, syringes, Cap-Chur gun, and the use of new drugs have resulted in considerable success. The purpose of the present paper is to (1) review briefly some of the progress made recently in immobilizing large

[1]Trade name for the carbon-dioxide-powered gun sold exclusively by the Palmer Chemical and Equipment Company, Incorporated, Atlanta, Georgia.

mammals in the field and (2) point out the contributions to conservation and research that can be made through application of the technique.

RESULTS OF SUCCESSFUL FIELD OPERATIONS

One of our most successful experiences during the past year has been with Uganda kob. Preliminary research began in 1958 when we used nicotine alkaloid to immobilize seven individuals, five of which were captured by Irven O. Buss and one of us (J.A.L.). For the purpose of studying territorial behavior, 50 mature male kob were immobilized and marked in 1959. The first four individuals were immobilized with nicotine alkaloid, at a rate of 4 milligrams per kilogram of body weight, and the remainder were immobilized with succinylcholine chloride (Table 1). One individual was killed to determine the minimum lethal dose of nicotine salicylate (16 milligrams per kilogram of body weight), and one individual was killed to determine the minimum lethal dose of succinylcholine chloride (0.44 milligrams per kilogram of body weight). No other fatalities resulted from the use of the paralyzing drugs. Only certain dominant individual males were selected in this study, and these animals became more difficult to approach as the research progressed, the flight distance (distance between observer and animal at which the animal ran off) increasing from 30-40 meters to 60-80 meters. In our best performance one of us (H.K.B.) marked 23 individuals in seven days. Had we not been highly selective, this number could have been increased two- or threefold.

In June, 1959, we moved two pregnant female kob 75 miles from Lugari to West Suk in Kenya, demonstrating not only that these animals can be immobilized but also that they can be transported

TABLE 1. EFFECTIVE DOSES OF SUCCINYLCHOLINE CHLORIDE[1]

Species	Vernacular Name	Effective Dose Milligrams/Kilogram Body Weight Male	Female	Number of Animals Effectively Immobilized
Adenota kob thomasi	Uganda Kob	0.35	0.35	46
Alcelaphus buselaphus lelwel	Jackson Hartebeest	0.30	..	1
Diceros bicornis bicornis	Black Rhinoceros	..	0.13	4[2]
Equus grevyi	Zebra	0.19	..	2
Giraffa camelopardalis rothschildi	Rothschild Giraffe	0.20	0.17	7[3]
Hippopotamus amphibius	Hippopotamus	0.10	0.10	3[4]
Kobus defassa ugandae	Waterbuck	0.35	0.35	4
Syncerus caffer	Cape Buffalo	0.05	..	1[5]

[1]Taken, in part, from Buechner, Harthoorn, and Lock (1960).
[2]Must be given in the neck region.
[3]In two doses given at 15-minute intervals.
[4]Hindquarters only immobilized with this dose, but sufficient for marking purposes.
[5]With atropine at a rate of 0.1 milligram/kilogram of body weight.

easily under tranquilizing drugs. This dress rehearsal has provided some of the necessary knowledge for translocation of two hundred to three hundred kob from the Lugari farming area, where the sole remaining herd of about five hundred kob exists in Kenya, to suitable habitat elsewhere in the country.

During the same field operation in the farming area of the Kenya Highlands near Kitale, we also demonstrated that Rothschild giraffe could be immobilized. Only three or four small herds of these giraffe remain in Kenya, and there are probably not more than five hundred extant in the whole of Africa. They are reported to damage fencing and certain types of crops, such as sunflower and sisal, in the Kitale area. Six individuals were immobilized successfully and tagged. Details of this operation and the reaction of the giraffe to the drug have been published (Buechner, Harthoorn, and Lock, 1959). As a result of this pilot experiment, it is planned to move about twenty-five of these giraffe into the Riva location of West Suk where their behavior and population growth will be observed. If this preliminary venture should prove successful and the translocated herd shows evidence of establishing itself in the new surroundings, further groups will be moved to the same area, and also possibly to one of the Uganda national parks. The eventual objective is to leave only one or two small herds in the original farming area so that their numbers will be compatible with farming interests.

Determinations of the effective doses for Jackson hartebeest and waterbuck were not difficult, as the taxa of antelope are relatively tolerant to succinylcholine chloride (Table 1). The single hartebeest which we immobilized showed less tolerance to the drug than the kob; therefore, our initial dosage may be somewhat high. In contrast, the first waterbuck we immobilized took twice the dosage of the hartebeest without respiratory distress. Tests of the dosage on three additional waterbuck showed that the dose is the same as for the kob.

Rhinoceros, buffalo, and wildebeest, on the other hand, have a narrow latitude for succinylcholine chloride, and we experienced considerable difficulty in assaying the correct dosages. The dosage for rhinoceros was ascertained by one of us (A.M.H.) after a prodigious amount of experimentation in the field. All of the several rhinoceros that were darted in the buttock ran a long way and had to be roped or else they got away altogether. Success depends upon injecting the drug either in the neck proper or in the large hump behind the neck. The use of succinylcholine chloride for immobilizing rhinoceros in the field is practical.

The practicability of using succinylcholine chloride for field immobilization of buffalo and wildebeest is still uncertain. After the first four attempts to determine the correct dose for buffalo, we concluded that these animals, for lack of sufficient plasma cholinesterase or for some other reason, simply could not hydrolyze the succinylcholine chloride. One buffalo was finally immobilized successfully with succinylcholine chloride and two using tubercurarine. Atropine was used to prevent prolonged apnea.

Our experience with wildebeest was similar to that of buffalo. In one week of intensive field work with the help of Lee M. Talbot, who has been conducting research on migrations of plains ungulates in the Serengeti National Park area under the sponsorship of the National Academy of Sciences and National Research Council, we were unable to find the correct dose of succinylcholine chloride for wildebeest. Later, Lee Talbot successfully immobilized wildebeest with 2.2-2.6 milligrams of nicotine alkaloid per kilogram of body weight injected intramuscularly. The dose with succinylcholine chloride will probably be approximately 0.09 milligrams per kilogram of body weight.

Apparently buffalo and wildebeest have a greater tolerance for nicotine alkaloid than for succinylcholine chloride, and practical field operations may require the use of the former despite the undesirable features of danger to the technician and the rigorous effects on the paralyzed animal. Flaxedil [tri-(diethylaminoethoxy) benzene triethyliodide] is showing considerable promise for use on the more susceptible animals such as buffalo and giraffe and has the advantage that recovery may be greatly facilitated with the injection of Neostigmine. This procedure may balance the difficulty in judging weight accurately in large animals such as giraffe. The development of new immobilizing drugs is being carried out by one of us (J.A.L.).

In North America succinylcholine chloride has been found to be a very successful drug in immobilizing trapped grizzly bear (Craighead, Hornocker, Woodgerd, and Craighead, 1960). In south-central Alaska and in British Columbia, 25 out of 40 moose were successfully immobilized with nicotine alkaloid (Rausch and Ritcey, 1960). Post (1959) found nicotine alkaloid unsatisfactory for immobilizing elk, but eight of ten penned individuals were successfully paralyzed with Flaxedil. No attempt has been made to survey all of the scccessful field operations in immobilizing large mammals in North America, and doubtlessly the detailed reports of several successful operations will appear in publication during the next year or two.

One of our most important conclusions from this initial work is that dosages and field techniques for each animal must be assayed by scientists. Each new species is an unknown quantity in terms of effective and minimum lethal dosages, behavior on approach, and physiological reactions to the drugs. Furthermore, the equipment has not been perfected for field work; and, therefore, exceptional precaution is required in the preparation and care of syringes, and the Cap-Chur gun must be kept scrupulously clean. The extraordinary number of variables, many of which cannot be anticipated, encountered in the field operations are sufficient to discourage easily those operators who do not have training, experience, proper scientific attitude, patience, skill, and knowledge of the habits and behavior of the animals concerned. Recent improvements in the carbon-dioxide-powered Cap-Chur gun have increased its range to 75 yards, and this range can be increased considerably with powder-charge modifications, thus overcoming the obstacle of limited range. Nevertheless, many uncontrollable factors remain. For example, wind easily deflects the large syringes, the syringe must reach the animal but not strike so hard that the hide is penetrated by the whole syringe, and the syringe must function properly to deliver the drug. Using the syringe described by Crockford, *et al.* (1958), a varying amount of "blow-out" may occur while the syringe is in flight. We have verified this fact by motion pictures. Therefore, the dosages given in Table 1 may in some instances represent approximations only. However, the results with 50 kob were so constant that we believe the dosages to be reasonably accurate. A recent modification of the syringe prevents "blow-out" of the drug as the syringe does not discharge prior to impact with the animal.

Despite considerable success in the immobilization of large land mammals during the past year, it must be recognized that immobilizing techniques are in their infancy and that great strides are likely to be made only with the improvement of the equipment and the development of a variety of new drugs. We hope that the present report will encourage other workers to participate in the application and development of the techniques. The significance of capturing and marking in research on population phenomena, behavior studies, and ecology of large mammals is clear. We anticipate acceleration of research in these fields, especially with ungulates, and we feel that such research will be fruitful in developing better understanding of natural populations of these mammals. Such knowledge will provide the basis for sound conservation measures required in the preservation of some species in our modern world. It seems worthwhile, therefore, to elucidate some of the areas of research in which the immobilization technique will prove useful.

APPLICATIONS OF THE IMMOBILIZING TECHNIQUE

In the future, field studies of large mammals at the population level will be improved greatly through being able to mark individuals. We can now foresee the possibilities of more exacting investigations of such population phenomena as growth rate, growth patterns, mean annual adult mortality rate (turnover rate), social behavior (including territoriality), migration, intra- and interspecific relationships, and mechanisms for natural regulation of numbers.

Consider, for example, the opportunity for experimental studies of functions in populations of African ungulates. In the attempt to preserve these animals there is likely to be much translocation of small herds from one area to another within the next decade. New populations will be started in areas where a given species does not exist. The rate of population growth could be measured through repeated aerial counts and/or calculation of population size using the Petersen Index. These two methods complement one another, as one may be more suitable than the other at certain population densities. The history of different age groups could be traced throughout the period of population growth, and changes in age composition of the population could be investigated as the population achieved homeostasis. It may be possible to measure changes in natality as the population increases, and it would be possible to measure changes in mortality rate in different age groups. Changes in social behavior are likely to occur with increased population density, and these changes should be studied with special attention to territorial behavior. When, for example, does the phenomenon of territorial behavior become established in the developing population and how is it related to regulation of numbers? Conceivably experiments could be designed to investigate the difficult area of natural regulation of numbers. It may be possible to study regulatory mechanisms as they enter the population growth equation with increased population density. In this regard, it may be possible to measure the fundamental functional relationships between predators and vertebrate prey populations. Furthermore, it may be possible to study interrelationships between species in patterns of population growth when two or more new populations are established. This has far-reaching significance in understanding (a) inter- and intraspecific competition, (b) the influence of one population on another, (c) the forces and mechanisms of adaptive radiation into distinctive ecologic niches, and (d) reproductive isolation through genetic drift.

In the area of conservation, the technique will contribute very significantly during the next ten years in the preservation of wildlife in Africa. Considerable translocation is required to adjust, where possible, wild populations of large mammals in proper relationship to changing patterns of land use. Demands are being made by landowners and government agencies to remove large wild mammals from farming and grazing lands to avoid damage to crops, reduce grazing competition, and control trypanosomiasis. Some of the lands involved have been utilized for agricultural purposes for many years. On other lands large schemes are in progress to make more land available for cultivation and pasturage. Fortunately, many areas exist into which the animals can be moved. It is in these localities that opportunities will be available for research on population behavior and ecologic problems. It would be well for the governments, universities, and other organizations interested in preservation of African wildlife to anticipate these opportunities and initiate gathering data when new populations are started.

If conservation through translocation of populations is to be successful, careful attention must be given to placing species in habitats where they will survive but will not interfere with other species to the detriment of natural communities or management objectives. To accomplish effective translocations, ecologists must be employed to conduct preliminary investigations, direct the shifting of species, and follow the performance of newly established populations.

SUMMARY

A table of doses of various drugs for field immobilization of large African mammals is in progress, and the results to date are presented. The animals varied greatly in dosage required and in response to the paralyzing drug; and it is, therefore, essential that the initial research be conducted by experienced scientists. The potentialities in studying social behavior and the dynamics of populations through marked individuals have far-reaching significance in increasing knowledge about natural populations of large mammals. The techniques of immobilization and translocation may be an important factor, during the next decade, in the preservation of African wildlife. However, as with the research, success depends upon applying the techniques under the direction of scientists familiar with immobilization and tranquilizing procedures.

ACKNOWLEDGMENTS

We wish to express our appreciation to the personnel of the Uganda Department of Game and Fisheries and the Kenya Game Department for their excellent cooperation in making possible the field studies on which this paper is based. Dr. Irven O. Buss, professor of wildlife management at Washington State University, read the manuscript critically and offered many valuable suggestions for improvement.

LITERATURE CITED

Buechner, H. K., A. M. Harthoorn, and J. A. Lock
1959. Using drugs to control game. Wild Life, 1(4):49-52.
1960. A new method of control of African wild animals. Nature, 185:47-48.
Craighead, John J., Maurice Hornocker, Wesley Woodgerd, and Frank C. Craighead
1960. Trapping, immobilizing, and color-marking grizzly bears. Trans. N. Am. Wildl. Conf., 25:346-363.
Crockford, Jack A., Frank A. Hayes, James H. Jenkins, and S. D. Feurt
1957a. Nicotine salicylate for capturing deer. Jour. Wildl. Mgt., 21(2):213-220.
1957b. Field application of nicotine salicylate for capturing deer. Trans. N. Am. Wildl. Conf., 22:579-583.
1958. An automatic projectile type syringe. Veterinary Medicine, 53:115-119.
Hall, T. C., E. B. Taft, W. H. Baker, and J. C. Aub
1953. A preliminary report on the use of flaxedil to produce paralysis in the white-tailed deer. Jour. Wildl. Mgt., 17(4):516-520.
Post, George
1959. The use of curare and curare-like drugs on elk (wapiti). Jour. Wildl. Mgt., 23(3):365-366.
Rausch, Robert A. and Ralph W. Ritcey
1960. A comparison of field tests with nicotine salicylate and the CO_2 propelled syringe. Unpublished typewritten manuscript, 11 pp., including 1 table.

DISCUSSION

MR. JULIAN HOWARD [Wichita Refuge, Cache, Oklahoma]: Does your experience give any clues as to whether or not this technique would be successful on the American bison and elk, and, is there any residual effect that would prevent the meat from these animals from being suitable for human consumption?

DR. BUECHNER: I am sure that you can work out a dosage for bison. and the meat is edible if you use succinylcholine chloride. In fact, in working with this drug, you can get it on your hands, and even a drop in your mouth. It does not cause poisoning because it's very quickly broken down into natural body metabolites.

There is a publication by Post to which I referred in the paper about immobilizing elk with Flaxedil. This was under penned conditions, and I don't know how it will work under free-roaming conditions, but I suspect that it would be successful. I also very strongly recommend using succinylcholine chloride to at least in an experiment determine the dosage for elk; I believe it can be done, and this would be probably the most satisfactory drug.

MR. BRUCE WRIGHT [New Brunswick]: I would like to ask Hal if he has tried this out on large predators—lions or cheetah or anything like that.

DR. BUECHNER: We haven't done that yet, Bruce, but we are planning on it.

DR. JOHN BUCKLEY [Laurel, Maryland]: I would like to ask if he had a Cap-Chur gun and at what ranges he was successful.

DR. BUECHNER: Most of the work was done with the standard CO-2 gun which has a range of only 40 yards. There is a new modification of the CO-2 gun which came out within the past two or three months bringing the range up to 75 yards. In East Africa we also used a powder charge gun which I won't take time to describe. With that system we could get up to 90 or 100 yards rather easily.

The difficulty with the powder charge gun is that the impact is likely to be so great that the syringe penetrates the hide, and one must be very careful to use it only at long range or at least adjust the powder charge so the syringe will not hit with too great an impact.

TECHNICAL SESSIONS

Wednesday Morning—March 9

Chairman: FARLEY F. TUBBS
Assistant Deputy Director, Information and Education;
Michigan Department of Conservation, Lansing, Michigan

Discussion Leader: JAMES K. VESSEY
Regional Forester, U. S. Forest Service, Atlanta, Georgia

PUBLIC RELATIONS AND EDUCATION

NATURAL RESOURCES AND PUBLIC RELATIONS IN EUROPE

WALTER P. TAYLOR
Claremont Graduate School, Claremont, California

This paper will attempt to give some impressions derived from a recent trip which took us some 20,000 miles to Europe and the Mediterranean area, where we visited 17 countries in ten and one-half months.

We were anxious to visit as many natural and wild areas as possible, and to see for ourselves some of the conservation problem areas we had been reading about. We also wanted to find out what the various countries were doing about their natural resources and public relations.

In London, *England,* we found ourselves part of a throng of 1,852 members and their friends from 66 countries attending the XV International Congress of Zoology. It was a bit disappointing to note that out of 72 sessions and 486 scientific papers only a single section and 5 papers dealt directly with the conservation of nature. Some words written a good many years ago by Professor Harvey Monroe Hall, the eminent botanist of the University of California at Berkeley, still seem to be appropriate. Following a study of European attempts to protect natural conditions, Hall wrote (1929, p. 684):

"As to scientific reserves in America, the chief deterrent to their formation is the absence of enthusiasm and organization among the scientists." Alas, too many zoologists, both in Europe and here at home, seem to be a great deal more interested in the minutiae of nomenclature than in the present and future status of the species whose names they are discussing. (I would like to hope that when the XVI International Congress is held in the United States in 1963, a little more attention can be devoted to conservation.)

Speaking in the session on "The Conservation of Nature," E. M. Nicholson (XV Int. Congress, 1959, pp. 53-55) emphasized the fact that conservation of habitats is no less important than the conservation of breeding stocks. He said, "If conservation of nature is to be something more than a belated salvage operation for a few nearly extinct species, if it is to be positively integrated with all human activities impingeing on the landscape, then it has got to become part of the conscious and articulate inheritance of the human race. . . . Many of the problems confronting us today in world politics and economics are closely linked with the failure of mankind to learn to think biologically. . . . It is now the task of biology, and in particular of zoology, to bring mankind back to the proper study of man in relation to his whole environment, and consequently to the conservation of that environment as a home for man and his fellow creatures on the earth." Those were eloquent words, but in the multiplicity of detailed studies reported on in London they were all but drowned out by the ultra-specialists.

High honors, however, to Nicholson and his associates who are doing their best to give substance to these sentiments. The British Nature Conservancy, with its approximately 87 nature reserves in England and Scotland, of which Nicholson is Director-General, was officially created a little more than ten years ago (March, 1949) under the auspices of the Privy Council of Great Britain. The Conservancy is maintaining areas to serve as (1) outdoor laboratories (2) living wildernesses (3) places to study natural ecological processes (4) sites for preserving rare plants and animals from extinction (5) places affording limited opportunity for recreation.

If crowded England can do these things, seemingly there is little excuse for less congested areas not to do them. The system of nature reserves in England is emerging from the free cooperation of many public and voluntary bodies and private persons, assisted by the Nature Conservancy in behalf of the Crown. We who have had some experience in cooperative wildlife research and administration can appreciate some of the difficulties involved. As Nicholson writes, ". . . Nature Reserves are still a novelty and it is to be hoped that with the help of the Press, the B. B. C. and public opinion it will become better understood that public enjoyment of Nature Reserves involves special restraint in the interests of the wild life and of the requirements of the scientific studies which have to be pursued on them. In one way or another the Nature Reserves will have to be assured of protection from human thoughtlessness.'' (Nicholson, 1957, p. 33).

A few weeks after our London visit we arrived in Athens, Greece (on September 10, 1958) for the meeting of the International Union for the Conservation of Nature and Natural Resources. Here met the Sixth General Assembly and the Seventh Technical Meeting of the Union with more than 300 delegates in attendance, 260 of them from countries outside of Greece. Fifteen governments, seven international organizations, and forty-three countries were represented. Unlike the International Congress of Zoology, the International Union for the Conservation of Nature is definitely, and one may say almost wholly, oriented in the direction of conservation research and its applications the world around. Through its meetings and its generous publications it constitutes potentially one of the most powerful public relations agencies on earth in this field. On a painfully limited budget the I U C N is trying to do for the whole world what nations with many times the available spending money often fail to do within their own boundaries. The projects of the I U C N include these primary tasks (1) Promoting scientific research (2) supporting popular international education and (3) serving as a clearing house for international conservation.

Sample specific projects given attention include ecology, barrages, cooperation with member nations (as in conservation in British East Africa, Belgium's Forest of Soignes, documentation for new-literates in Asia, damage by weaver-birds in Africa, Japanese national park defense, bird weeks in Japan and Argentina, International Convention on Oil Pollution of the Sea, Central African vernacular edition of I U C N lessons, an international commission for soil and water), legislative and administrative enquiries, consideration of auto-route and town and country planning (Paris's Green Belt, etc.), International Youth Federation, publications, scientific missions (Middle East, Galapagos, Madagascar), and ecological education (UNESCO-IUCN-FAO, conservation courses in Russia, chairs of ecology, International Commission on Education.)

From the standpoint of the present public relations program the work of the I U C N Commission for Conservation Education is of special interest. In response to a questionnaire the Commission got together a good deal of material on the status of conservation education in thirty-five countries. Perhaps of special interest to us at this time is the material from the Union of Soviet Socialist Republics, which reads as follows:

"No formal conservation courses are offered, but the universities put great stress on such information in many fields. Biology, botany, forestry, agriculture, zoology, fisheries, soil science, water conservation are included in Engineering and other schools. The problems of air contamination, the role of air in the life of plants and animals and in soil fertility is emphasized in a number of courses. Much conservation information is furnished in these courses.

"Conservation information is included in the reading books for the primary schools. Secondary school courses in biology, zoology, and geography include conservation data.

"Teacher training schools provide special lectures, and students in these schools participate in organizing and arranging the Day of Birds, the Day of Forests, the Week of Gardens, etc.

"Special efforts are made to improve the conservation knowledge of biology teachers.

"The young naturalists of schools and other children's establishments participate in such projects as collecting seeds and fruits of wild plants, school nursery gardens, tree planting, and helping to protect parks and gardens. Great stress is placed upon student participation in conservation activities.

"Much conservation literature and instructive material is available from many organizations."

In general, the Commission found a wide interest in conservation education, but to the present writer efforts in the various countries seem woefully inadequate. One of the weak places was pointed out by the Assistant Secretary General:

"With the exception of a very few countries, school education contains virtually no matter intended to explain to the child his place and part in nature (and the universe) on which he depends. There is virtually nothing designed to impress upon the spirit of youth the importance of this problem both for the survival of the individual and for the future of nations and of relations between them." (Phillips, 1958, p. 18).

Obviously problems in the conservation field are most urgent and critical in underdeveloped countries, especially in Africa. There the main problems are said to be two: (1) To ensure that development follows acceptable standards of conservation and (2) to make sure that the African peoples fully accept the principles of and need for the conservation of their natural heritage.

Dr. F. Bourlière, of the University of Paris, a member of the

Executive Board of the I U C N, told the writer that special efforts are to be made at the Warsaw meeting this year to help the new African nations as much as possible.

Recommendations by the Commission for Conservation Education were three: (1) Repeat the survey of the present status of conservation education at some future date with special reference to countries not reached in the present effort or which failed to respond (2) Undertake the preparation of simple manuals for teachers covering soil, water, flora and fauna, but the Commission should (3) not try to develop material for student use in primary or secondary schools.

Our impression of the I U C N N R as a whole is of a relatively small band of dedicated leaders working with pitifully inadequate funds on one of the biggest and most difficult jobs on earth. These workers are confronted with heavy odds, including language barriers, lack of sympathetic understanding and support, and failure of some nations to cooperate. Worldwide reactionary forces, made up of ignorant and selfish exploiters, are always solidly against conservation efforts. In the vast areas, particularly in the Orient and Africa, in which illiteracy and primitive mores hold sway, the task seems well-nigh hopeless. In conservation, this is One World whether we like it or not. Surely we ought to promote membership on the part of Governments and private organizations in the IUCNNR, and do what we can, with what we have, where we are (as Theodore Roosevelt would have said) to speed world-wide education in natural resources.

By no means all our observations in Greece were confined to the formal seminars at the Athens Graduate School of Economics and Business. We were taken on a number of short excursions, then took part in a much longer trip which took us to Delphi, Thermopylae Pass, Lamia, Larissa, Trikkala, Meteora Monasteries, Metsovo (in the central Pindus Range), Jannina, Agrinion, Mesolonghi, and back to Athens. This was a wide circuit through the mountainous back country of Greece. Here we were impressed with the widespread deforestation, overgrazing, and soil erosion. We called to mind that "The soil of Greece became poor only after the civilized Greeks started misusing it" (Dale and Carter, 1955, pp. 104-106). More than two thousand years ago some of the Greek philosophers saw what was happening. Plato wrote ". . . what now remains of the once rich land is like the skeleton of a sick man, all the fat and soft earth having wasted away, only the bare framework is left." Even two centuries before Plato (427 to 347 B.C.) Solon had observed that the soils of Attica were becoming unfit for grain farming. About that time Peisistratus is reported to have paid bounties to Attica farmers and landowners for planting olive trees on sloping lands. In the fourth century B.C. Theophrastus advised Greek farmers to plant grain only on the best land and use the hillsides for vines and trees. The skeleton of a sick man! That graphic comment by Solon still applies to much of Greece. And now she has become to a degree dependent on the largess of others. Exercising themselves most valiantly, Greece's leaders, as fine a group of men as one could meet anywhere in the world, are endeavoring by herculean endeavors to rebuild some of Greece's former greatness. As we traveled about the land, we could not help but wonder whether we in North America, through our complacency and our devotion to immediate profits, are not trending in the same direction. It is an interesting and somewhat dismal fact, that no civilization anticipates its own ending.

I'd like to spend some time on *Turkey,* America's staunch friend in the near East. There we met a number of American educated young men, who are doing much, in cooperation with other Turkish leaders, to strengthen the agriculture, range management and forestry of the country. Since, however, we cannot take time to dwell on the complex problems encountered in Turkey, let us fly over to *Israel,* the land of Shallom! (peace).

Here is a small country ". . . no larger than the state of New Hampshire," established in a moment of "high opportunity and deadly danger" (May 14, 1948 at Tel-Aviv) situated ". . . in the hills of Galilee, the plains of Sharon and the wilderness of Negev." (Ramsey, 1960, p. 54). Here "There is a tale behind every quiet mound, every shady olive grove, every peaceful shrine. . . ." (Israel, Treasury of Legend, Govt. Tourist Corporation, Jerusalem, Israel.) But Israel lives, not in the past, but in the present and future. Her people are aggressive, determined, industrious, and vitally alive. Only 40 years ago they numbered but 50,000; 10 years ago they had grown to 600,000; and now they approximate 2,000,000. Thousands more are coming each month. "The gates of Israel are open to them and shall remain open." "We are lucky to have assistance from the outside—but the sweat and toil are ours." (Visitor's Guide to Israel).

What Israel lacks in quantity she is trying to make up in quality. One of the factors in her progress is the extent to which she can train scholars, professional men, scientists and technicians of high caliber. (Facts About Israel, 1957, p. 123).

The prospect of survival in this relatively restricted area, surrounded by millions of hostile Arabs, daunts the Israelis not at all. Mr. N. Gil, Chief of the Israeli Soil Conservation Service, told us Israel is the safest place in the world to live.

The Government is losing no time in making scientific plans for the future. With the assistance of the F A O and the United States Operations Mission to Israel Gil and his associates have mapped every square foot of the country with a view to its best future use. Detailed maps have been prepared showing lands suitable for irrigation and for dry land farming. Soils have been charted and erosion recorded. I asked Mr. Rosensaft if they had any illustrations available from which I might make a selection. He replied, 30,000!

Our own Walter C. Lowdermilk, who headed the foreign contingent for three years (Gil and Rosensaft, 1955, p. 52) has had a large part in Israel's accomplishments, and is widely known there and universally popular.

Piloted by N. Gil and other members of his staff, also by Dr. and Mrs. Hugo Boyko (Director, Agricultural Research Station, Ministry of Agriculture, Rehovoth) we were able to observe a goodly part of the country, between Lake Tiberias and Haifa on the north and Sede Boqer (in the Negev Desert) on the south, and from Tel-Aviv and Ashquelon on the Mediterranean to Jerusalem and the Jordan River on the east.

One thing that impressed us immediately was the absence of conspicuous grazing animals. The Israelis have faced up to a problem of reduction of grazing by domestic livestock which has baffled the authorities in Greece, Yugoslavia, Italy, and Spain. Mr. Gil explained that Israel has passed a law against grazing by goats. While a few herds are still to be seen, it will not be long, he said, until all goats are eliminated. It is permitted to replace goats with sheep, but the sheep will be adjusted to the determined carrying capacity of the land. In order to assure better control of grazing 1,000 kilometers of fencing had been built already in the three years up to 1958. It is planned eventually to do away with herders entirely, confining the sheep to fenced allotments made to each owner. Some of the sheep herders, said Gil, are highly literate; a few actually use the time while they are herding sheep for reading and thinking! Why wouldn't this be a good job for a retired college professor or government man?

The spirit of the work going on in Israel is well expressed in the story of Honi the wise and righteous: "One day he saw a man planting a carob tree, which is said to take seventy years to bear fruit. 'Why do you do that at your age?' he asked. 'My grandsire planted trees for me' answered the old man, 'and I plant trees for my grandchildren.' "

According to Bodenheimer (1957, p. 386) conservation efforts in Israel come none too soon. He writes, "It is only less than 3,000 years that historical man began to dominate nature, which means that he started to destroy it recklessly by utilitarian exploitation, bringing the country rapidly to the rape of extreme erosion in which we find most of it."

It probably is inevitable that the intensive land use necessitated by Israel's burgeoning population, fed by further streams of immigration, threatens even further the natural flora and fauna. In regard to plants Zohary (1958) points out that a number of endemic and other rare plants have not been found in recent years. He lists 34 rare species on the verge of extinction, and says there are many others. Hydrophytic vegetation, as in the United States, has suffered severely from drainage activities. Halophytic communities along the coast are also threatened. Worse yet, unless prompt measures for their protection are taken, the relatively small number of sacred forests which have been preserved through the ages are threatened with destruction. Examples are the remnants of *Pistacietum atlanticae* in Dan Valley or in Sharon Plain and the stands of *Quercus calliprinos* on Mount Carmel and near Jerusalem. "The Botany Department of the Hebrew University has recently submitted to the Government a map indicating over sixty sites that deserve prompt protective measures. . . ." A Society for the Protection of Nature has recently been organized, but, aside from preliminary educational efforts, has been unable to secure the setting up of protected areas.

In the Report of the Ministry of Education and Culture (Israel Government Year-Book 5718-1957, p. 7) it is set forth that two-year courses for postgraduate nature studies are being carried on at Tel-Aviv University Institute and in the Biological Institutes in Haifa and Jerusalem. Youth Hostels, as in a number of European countries, are officially recognized. In 1956-1957 there were eleven of these in Israel, with 21,268 lodgers taking advantage of them. It is of interest that 5,225 lodgings were furnished to visitors from other countries. Rates per person at these hostels range from 11 cents to 28 cents for members of the international Y. H. A. All these activities undoubtedly contribute to improved conservation. The Ministry has an "Information and Civic Division," which gives attention to oral civic education, tours, and visual aids.

Time, unfortunately in short supply, fails me to mention other countries visited, except briefly.

Austria we found to be a grand country of mountains, valleys, forests and snow fields. In Vienna we found Dr. Lothar Machura, director of the Institute of Nature Protection, who (1951) is the author of a fine pamphlet on the national parks and nature protection in the United States. In this pamphlet he gives eloquent emphasis to the point that while there are national parks in many other countries there are still none in Austria. I am under the impression this has been remedied, but I do not have the latest information. Many years ago the city of Vienna set aside the so-called Vienna Woods. This internationally famous wooded area, often referred to as a source of inspiration of Shubert, Beethoven, and other great artists, surely lived up to its reputation. In Vienna we visited the immense Natural History Museum. We also travelled to the Seemuseum at Neusiedl, 32 miles southeast of the city. Here an old fisherman's house has been restored to house the Museum. The surroundings are arranged as an open-air extension of the Museum, so that the institution is closely associated with its own environment (Machura, 1957, pp. 168-169). Here Dr. Paul Schubert, a bright young entomologist, did the honors to the foreigners, and explained the organization.

While in Vienna we became acquainted with Dr. R. Liepolt and his assistant Dr. Elizabeth Eckl, who are associated with the "Bundesanstalt für Wasserbiologie," studying the waters of the Danube River as well as others throughout Austria. Quality of the water, hydroelectric possibilities, biology, Ph, chemical constitution, and pollution, are all given attention.

In the Wiener Programmspiegel for November 29, to December 7, 1958, we were amused to see the following comment:

"The Danube, called blue by Johann Strauss, will disappoint you in two ways—it runs on the outskirts of the city and it is not blue. Since Johann Strauss wrote his 'Blue Danube' many factories were built on its banks and changed her water into a dirty grey."

One of Austria's grand old men, Dr. Helmut Gams, ecologist and botanist, whom we met first in Athens, we later visited at his home institution at the University of Innsbruck. Dr. Gams is fluent in thirteen languages. He says all the iron curtain countries take an enthusiastic interest in nature protection. While we were in Innsbruck he invited us to his home and showed us personally taken Kodachromes of European national parks ranging all the way from Sweden to Greece.

Our visit to ***Belgium*** was high-lighted by visits to La Forêt de Soignes, through the courtesy of Dr. M. C. Bloemers, Secretary-General of the IUCN and his friend Count de Jonghe d 'Arbois. This forest, a 9,000 acre tract of beech and oak near Brussels, together with another forest nearby is said to be the last authentic example of the immense forest which covered that part of Europe in earlier times. Another famous site in Belgium is that of the Royal

Arboretum Geographique de Tervuren, planted in 1905 by King Leopold II. The trees are arranged in ecological groups over a tract of 400 acres, and represent 20 groups from different geographic sites in the New World, and 20 from the old. Visitors are welcomed, and the Arboretum serves an obviously beneficial public relations purpose.

Both La Foret de Soignes and Arboretum Geographique de Tervuren are close enough to Brussels to be worth millions of dollars if they could be developed and sold for residential or industrial purposes; but even in thickly populated Belgium, this is apparently unthinkable.

In *Holland* Dr. G. A. Brouwer, long-time president of the Netherlands Bird Protection Society, and Mrs. Brouwer took us to see one of their unbelievable conservation projects near Karndike, where some 57,000 hektares of land are being reclaimed from the sea. First the area is enclosed all the way around with a suitable dike. Then all the water is pumped from within the dike, leaving the land available for treatment and ultimate use for farm production.

Denmark we found to be a country of green fields, dairies, and vigorous ocean commerce. A delightful nation, perhaps the only one where the American Fourth of July is celebrated as in the United States. The occasion for this is the meeting of an association of Danes which gets together in Jutland each summer. So many Danes from the United States attend the meeting that actual celebration of the Fourth comes easy. Copenhagen is well equipped with a zoological garden, a beautiful aquarium, an outing club, and a nature protection organization.

What of the other lands? I simply lack time to discuss them. For example *Italy,* land of opera, music and art, is the country of the Abruzzi National Park, among the world's finest, where, at the delightful auto hotel at Pescasseroli, we were entertained by the Mayor and the representatives of the Ministry of Agriculture.

We were fascinated by *France*, an inscrutable and independent nation with its aggressive leadership in the IUCN, and in so many other good causes. Its breathlessly interesting monuments of the past were viewed with interest, signs and symbols of an age of artistic and at times, ruthless royalty. We liked the Camargue near Arles which reminded us of some of the great national wildlife refuges in the United States.

Spain, still struggling for better things, is to this day seriously handicapped as a result of the exploitation of the grazing resource over a period of 600 years (1200 to 1800 A.D.) by the Mesta, the organization of graziers which virtually ruled and ruined the country. While we were in residence in Madrid we read a short news item in the paper to the effect that a number of professors and students at the University of Madrid had been arrested for subversion.

Referring to *Switzerland* some one has said, "It is all right to envy the Swiss, for only they have Switzerland." The Swiss National Park is a refuge for the ibex and chamois, and doubtless the equal for scenery of any in the world.

Morocco, a young nation, is bent on advancement. Its leaders are striving for conservation, but so many of the people lack education that they are probably having an uphill fight. I called on Monsieur Brick, Minister of Agriculture, whom I first met at the IUCN in Athens. Two national parks have already been created. Sultan Mohammed V is said to be somewhat "Western" oriented. The question is, can he enlist the sympathy of his people? The one dominant idea at present seems to be "out with all foreigners," particularly the French!

Western Germany impressed us as strongly conscious of the need for conservation and education in the field of natural resources. If this vital nation will follow the lead of Herr Alfred Toepfer and the Naturschutzverein it will play an important role in European leadership.

Sweden, rich and prosperous, is said to possess a standard of living exceeding ours. It is a country of high intelligence and commanding accomplishment in the field of conservation, nature protection and education.

Norway is in some ways the most outstanding nation of all. With only 3 per cent of its country cultivable, its people depend to a great extent on fishing and forestry (besides farming), notoriously laborious occupations, for their living. Norway, practically flattened during the war, proceeds blithely on her way, self-respecting, strong, courageous and happy.

Meeting some of the wonderful peoples from these various lands, one cannot help but be proud of our relations with the nations of Western Europe, the home from which most of us came.

And finally our experiences in Europe and the Mediterranean inspired in us a new appreciation of the slogans displayed at the Brussels Universal and International Exposition: "Sophocles the golden presaged it. Universal brotherhood. They were born not for hate, but for love." And as Erasmus said, "I should like to be known as a citizen of the world: a friend of all nations of the universe." "Since the dawn of life man has sounded the heart of nature, delving into the irresistible mystery of her attraction. Our forebears struggled to master the forces of nature, and today's scientists are expanding the realm of man into the very depths of matter. All with one common passion: Understanding!" "Man cannot live by bread alone . . . the hunger of the spirit cries out of the depths. Work of Art, Work of Nature, All Beauty breathes love of peace. The need of harmony is the strongest of all the wants of men." "Love and the spirit will make the civilization of the future." The decade just finished marks the "Crowning of a Great Effort, Above All, A New Beginning."

Thus we were impressed that in the decade just ahead, the still bountiful resources of nature must come into their own. They must come to occupy a larger place in the thinking of man if he is to survive.

LITERATURE CITED

Bodenheimer, F. S.
1957. The growth of knowledge of animals in Palestine from Palaeolithic times. Proc. Zool. Soc. Calcutta, Mookerjee Memor. Vol., pp. 385-396.
Boyko, Hugo
1955. Climatic, ecoclimatic, and hydrological influences on vegetation. Reprinted from Plant Ecology (Proceedings of the Montpellier Symposium).
Commissariat General of the Government for the 1958 Brussels Universal and International Exhibition.
1958. Building a world for man. Illustrated pamphlet published in connection with the Exposition, Brussels, 28, Putterie.
Dale, Tom and Vernon Gill Carter
1955. Topsoil and civilization. Univ. Okla. Press, Norman, pp. xvi + 270.
Durant, Will
1939. The life of Greece. Simon and Schuster, New York, pp. xviii + 754.
Education and Culture, Ministry of
1957. Report for Israel Government Year-Book 5718. pp. 32.
Fifteenth International Congress of Zoology London 16-23 July 1958.
1959. Proceedings, publ. by the Congress, London, pp. lxxxiv + 1068.
Gil, N. and Z. Rosensaft
1955. Soils of Israel and their land use capabilities. Summary of Soil Survey, Part One. Pub. 54, Agric. Publ. Section, State of Israel, Ministry of Agriculture, Soil Conservation Service, Hakirya, pp. 52.
Hall, H. M.
1929. European reservations for the protection of natural conditions. Journ. Forestry 27(6):667-684, October.
Machura, Lothar
1951. National parks and Naturschutz in den U. S. A. Sonderheft der Zeitschrift Natur und Land, 37 Jahrgang, Heft 9 bis 11, Juli bis September 1951, pp. 141-188.
1957. Two homeland museums in Austria. Museum 10(3):168-175 (UNESCO).
Nicholson, E. M.
1957. Britain's nature reserves. London, Country Life, Ltd., pp. 175.
P[hillips], T[racy].
1958. List of sections to the secretary-general's report on the state of the Union for the period 1956/8. International Union for the Conservation of Nature and Natural Resources, Brussels, mimeographed, pp. 28.
Ramsey, Frederic Jr.
1960. Israel in speech, song, and story. Saturday Review 43(9):54-55, February 27, 1960.
Zohary, M.
1958. Wild Life protection in Israel (flora and vegetation.). Uncorrected proof, Seventh technical meeting, International Union for the Conservation of Nature and Natural Resources, Athens, 1958, pp. 5.

DISCUSSION

DR. GRAHAM [Washington, D.C.]: I don't have a question, but I would like to make a comment. I would like to endorse what Dr. Taylor said about the need for us in the United States to participate in international conservation affairs.

I think that each of our conservation organizations in this country could well afford to be a member of the International Union for Conservation of Nature and Natural Resources.

This word "interest" I think, is necessary for at least two reasons. One is that we need a great deal more conservation in our technical and economic assistance program. I regret to say there is relatively little conservation in the program, either our own ICA program, or the UN technical assistance programs. The second reason is that we have a great deal to learn from other countries and a great deal, in particular, to learn from Western Europeans.

I will give you one example. Their concept of what they call "landscape and landscape preservation" and this has to do with their feelings for the environment. There is in Western Europe a concept of environment and a feeling for it, which well illustrates what Leopold used to call an ecological conscience, and this of course, is certainly something that we can profit from.

I would only heartily endorse what Dr. Taylor has said about our participation in world conservation affairs.

DR. LEONARD [Michigan]: I would like to ask Dr. Taylor whether the Western Europeans are making as heavy use of pesticides as we appear to be doing in this country. It is quite an inflammatory thing here.

DR. TAYLOR: I do not have any of the details on the use of pesticides there. However, I am sure that they are having parallel problems because it was one of the topics brought out at the International Union for the Conservation of Nature. They are concerned with reference to what Ed said about cooperation. But one of the biggest functions of this international union is conservation education.

One thing they point out is that in no country in the world—and they have recently by questionnaire determined this point with many others in connection with conservation education—are sufficient efforts being exerted to teach the child, as he grows up, his relationships and his dependencies with nature around him, or the universe around him. That seems to be very inadequately treated.

I am interested in this program because Dr. Etter will be discussing a topic very much alive in this connection—keeping the child in touch with the earth. Apparently this is not being done in any country in the world to the degree it ought to be done and, without that, how can we hope to carry out adequate conservation programs?

MR. SELKE [Minnesota]: It happens that some of the countries which you have referred to are some that I have visited.

I wonder if you sensed or had the feeling that they were interested in conservation because they wanted to raise the physical standard of living—have more food, and so forth.

I felt that one of the things that Western Europe was losing, as well as perhaps some of these other countries, was the enrichment of life that we get from the conservation programs that we believe in, instead of just making a living.

It seems to me that in the days of the nobility, when they had large estates they frequently had conservation of the kind that even to this day provides opportunity for an enriched recreational life. Some of the foreign countries, and I think the United States also, underestimates the importance of conservation for enrichment of life, instead of just conservation for better living.

DR. TAYLOR: That comment is very pertinent. I was particularly impressed in the vicinity of Brussels—where we were taken out to the Forest Soignes—the big woods right close to the city of Brussels, which is relic of the beech forest which used to cover that entire part of Europe. There is also there an ecological demonstration which was introduced by King Leopold II and which contains some forty groups of tree species—20 from the New World and 20 from the Old World. This is a smaller acreage, something like 400 acres, but other forests are very large. The pressure from business interests and development interests on those areas must be tremendous.

Evidently, in overcrowded Belgium, a country which is probably more crowded than any other in Europe, there is not even any thought of that. I think that my general impression, without anything very definite to back it up, is that perhaps they are a little more sensitive to the conservation of these things for the making of the good life, aside from material things, than we are.

WHY MORE ECONOMISTS ARE NOT CONSERVATIONISTS

GILBERT BANNER
Economics Department, University of Tennessee, Knoxville

Elementary textbooks tell the student that economists explain how scarce resources are allocated in the production of goods and services, yet relatively few economists are noted for their interest or contribution to natural resource allocation problems. Conservationists, concerned with the allocation of scarce natural resources, rarely turn to economists for help. How may we explain this weak relation between two groups concerned with the same problems?

Several reasons may be advanced for the profession offering so little in this area.

First, most economists are specialists and are not concerned as economists with natural resources. Whatever the reasons, natural resources in general have not become a specialist's area, although we have had agricultural and land and forest economists for a long time.

Second, most economists are concerned with the production of material things, giving less emphasis to services, often simplifying their treatment of services as if they were the same as goods. If the services are intangible, they are easily ignored.

Third, most economists, at least in the textbooks, claim they make no value judgments; that is, in economic analysis, their work is free of value judgments. They leave to others the choosing of values and of policy. Economists merely explain and predict the behavior and results that can be expected from alternative choices. They often ignore their use of value judgments in choosing the tools and data to explain and predict.

Fourth, economists who might be interested in natural resources as a special case of resource allocation, start with the model and assumptions of the competitive free market, in spite of the criticisms of other social scientists regarding the assumptions of this model. They ignore to a large extent the institutional arrangements, the political behavior that underlies the market operation. They often treat the economy as if it were a private economy independent of the public sector.

Finally, there are economists aware of the natural resources problems, but also concerned with the unsolved social and political ills of our society and the world. Conservation to them is concerned with items of less than survival importance for the nation and the world. In this larger concern—recreation, wildlife to look at or shoot at, wild spaces for getting away from society and people, worries about the kind of living possible a hundred years in the future—these are minor problems.

If many economists say they take the value system as given, and if conservationists are concerned with changing the value system, both are not working in the same dimension. Without attempting at this point to define conservation beyond indicating that services and value judgments are important aspects, if economists don't make value judgments and if they do not consider services adequately, they may ignore the very problems that are the heart of conservation.

Economists describe our economy as a two-part system, the private sector making decisions through the price making machinery of the free competitive market, and the public sector making decisions through public vote. Public decisions can affect the institutions through which the private sector operates, as well as decide which functions should be the responsibilities of each sector.

Which activities belong in each sector? Goods and services that can be sold to individuals and thus have a price tag established in the competitive market have traditionally belonged to the private sector. (Cars and their tailfins.) Those productions that are for collective use and cannot be sold to individuals, and so do not have market prices, have belonged to the public sector. (National defense and public health.) For monopoly conditions, a market price can be set; but for lack of price competition, government regulation is unfortunately necessary in the public interest. (The regulated utilities.) These are the extremes; our problems lie between.

The competitive private market is supposed to allocate resources most efficiently according to the wishes or value judgments of the people. How well does the private market do this job? What should the role of government be if it does it well? What should the role of government be if the private market does not do so well?

The conservationist does not see society getting the happy results he thinks are possible from the use of the natural environment, and he asks, "Is it impossible to get better results because of the economics of the case?" For economic policy, as I see it, the conservationist is concerned that the economy consider two broad areas in its use of resources; that of facts regarding natural resources, and that of values in natural resources use. He is concerned with facts about efficiency of use in terms of known technology and present market conditions; facts with regard to interdependencies and limitations of use within known science and technology, both natural and social; facts with regard to disservices or social costs that do not get accounted for in private accounting. Conservation is concerned with values in the sense of making judgments about the potentials that might be obtained from resources, and judgments with regard to responsibilities of resource users to the public interest.

What does conservation mean to the majority of economists? Conservation because of its "moral goodness" is used as a slogan to the extent that the word itself is meaningless. Yet the invention of new words for the same idea merely invites repetition of the same process. I believe it more effective to use the old terms and carefully define the behaviors or relationships one is concerned with. Unfortunately, economics as a discipline, takes common words and gives them specific technical meaning, to the confusion of students. Some economists, following this procedure, have limited their use of the word *conservation* to a very specific part of the problem, to the confusion of conservationists, and often economists. The danger in this approach is the tendency to forget those parts of the problem that have been left out by the definition. If the market does not handle intangibles, call this a problem of values and leave it out. Because the term *conservation* is meaningless to many economists they prefer not to use it at all, and speak of natural resources problems.

How does the economist fit natural resources into his picture of the economy? We have to examine this picture. The economist builds a model, an abstraction of the system, to make it easier to understand. He would like to see order in this system. He starts with some make believes, some assumptions of the real world, then explains what happens in the allocation of resources, and the end results one should get. Then he turns to the real world and says, "Since my assumptions are close enough to the real world, the results you get are the best you can get." He would like to believe there is order in the system, that it naturally and automatically gives the ideal end results for society.

But what if the assumptions do not resemble the real world? "Imperfections" the economist calls these differences. Then there is no reason to assume logically or rationally that the end results are ideal. They are merely the end results of the existing conditions. But it is hard for some to accept the possibility that there is no automatic order in the system; that we get whatever our institutional arrangements give us.

What is the importance of this difference between assumptions of a model with order and a real world that does not have this order? The model of the competitive free market assumes that prices reflect the preferences or value judgments of the public in resource allocation. The opportunity to use resources differently exists, and these alternatives have been considered in arriving at the market price through the play of supply and demand. Add it all up and you get the greatest amount of goods freely picked by the public. If this order exists, then simple advice to anyone who does not like the choices of the market is to educate the people so their behavior gives allocation closer to that desired. If you want a different allocation, change people's values and this will be reflected in the market. Do it through the market.

If the results of the market are naturally ideal, you must not tamper with the natural workings of the automatic system, or you will get results less good. The implication of this orderly system is that it determines potential values. The market system is a value system itself, and often becomes an end in itself as well as a tool. If the market does not do it, it should not be done.

Reality does not permit many economists to hold to this extreme, for the imperfections are too evident. They do not accept the illogical circle; what is, is best. They ask, "How do the imperfections interfere with the allocation job the market is supposed to do? How may it be corrected?" They also ask, "How badly does the public sector do its job, and how may it be corrected?" The market mechanism is a tool for getting a job done, and one must have a value system to judge the degree to which it is doing the job. The market should not determine values, but values should determine the operation of the market.

This wide spectrum of economic thought with regard to the results of the market means just as wide a set of views toward conservation ideas. To some, conservation is no more than conflicting value judgments, worded in indefinite welfare slogans. The same idea to other economists indicates a concern with specific imperfections in the operation of the private sector. To some, conservation is a small part of economic analysis, allocation over time, or increased efficiency. Others see economics and conservation as different parts of the same broad man/resource relationship; conservation being a concern on scientific and moral grounds with determining and achieving potentials from resources, economics as one discipline of many, being concerned with the machinery or behavior by which resources are used.

For all economists however, conservation is criticism of the workings of the private market economy, whether irrational value judgments, or rational criticisms of imperfections, depending on the economist's viewpoint. If conservation is, in large part, criticism of the private sector, what are the viewpoints of the spokesmen of this sector regarding conservation? The business world is all for it, if it doesn't interfere with the private market and doesn't cost taxes, and is concerned with increased efficiency that results in private profit. Businessmen are defenders of free enterprise. How do they look at the two-part economy? Mostly, it should be one part. Free enterprise usually means freedom from interference by the public, freedom to use property as one wishes; productive property should be privately owned or controlled, all things can have a market price, anything new gets a market price. They claim the natural order of the market place under private production will produce the greatest social good with the greatest amount of personal freedom. Any interference means less freedom and less efficient production of goods and services. The private producer uses the slogans of the ideal model and ignores the imperfections. He ignores the conditions that are necessary to justify the ideal model, the controls that would keep individual self interest from being anti-social, and the government sector doing those things that the private sector cannot do. The private spokesman claims as a natural right, freedom without the competitive controls; freedom without the public responsibility. And he uses the political process to maintain or get these freedoms, and be free of the controls and responsibilities. He does not wish to consider social costs, intangibles, or potentials or the many other imperfections in the operation of the private sector.

In a democracy we can ask whether the resources allocation machinery does the job with the most freedom that is claimed for it. We can ask, "How well do market prices reflect value judgments of consumers; how well do costs reflect alternatives or opportunity costs; how well do politically established policies reflect the value judgments of the public?" Many economists would say, "Not so well."

Some imperfections of the free market are inherent, since the required assumptions cannot be met in the real world. Unequal income in the market cannot reflect equal voice of the public. Alternatives are not known to the public and mass advertising indicates the degree to which the public gets limited information. Pure price competition does not exist, because technology makes possible increased efficiency to size, and because other forces make for economic concentration. These imperfections make the real world bear little resemblance to the assumptions of the model. In addition the special nature of natural resources creates problems of defining property rights, putting valuation on non-market considerations, considering social costs—all imperfections the free market cannot consider. These imperfections do not bother the private production spokesman; he is not concerned with logic but with propaganda. He uses slogans for his own interest.

What about his view toward the purpose of the public sector? With economic power, and influence on mass media as well as other educational institutions, he uses his political power to maintain or increase his economic power. He uses, if he can, the political process to aid the private interests and prevent government interference with the private sector. He may even prevent the public sector doing those things that only the public sector can do. "Government should not do anything because only the private sector is productve," he claims. Government is not productive, only costly.

Resource problems then are not alone due to inability of the market to do what is expected of the market, but due to imperfections in the political machinery which gives undue power to producers of material things to influence the political and administrative process. Who regulates the regulators?

If resources could be allocated through a free market to give a high degree of welfare returns there would be no need for conservationists. The market would be sensitive to changing needs, new ideas and new values. Since the market cannot automatically do these things then machinery must be established by the public that will correct the imperfections of the market, or get results independent of the market.

If the economist is aware of the imperfections of the market and the self-interested claims of the private sector, why does he not try to clarify and educate the public on economic and political matters? To help the public understand the implications of accepting an inherently irrational market sector to determine values for society rather than the public sector, a sector which at present appears to be democratically irrational, but which is not inherently irrational, is a heavy dose of philosophy and logic for the economist to accept as his teaching responsibility alone. Yet he sees the private sector use its economic and political power to maintain or increase the imperfections rather than decrease or correct them. He can ironically point out that *subsidy* by definition is government funds that goes into someone else's pocket. Such funds are a necessary function of free enterprise government if they go into yours. Political interference with the market is a necessary function of free enterprise government, if done for the protection or improvement of private profit making. The same procedure is creeping socialism or worse if done in the name of protection of the consumer, the public.

Since criticism of the status quo would be making value judgments, this would not be economics and would not find a resting place in most of the professional journals. Obviously any criticism of this sort is not accepted easily by most mass media of communication. Even if their owners' philosophy were not identical to that of the private producer, they would hesitate to voice opinions that might interfere with advertisers' digestion and blood pressure, and their own pockets. Should the economist buy full page ads just to present his ideas? More to the point many feel it doesn't pay to buck the general opinion of the public and those who can put pressure on their economic security.

It is a difficult task to educate the public to the implications of permitting the private market to determine values for society. In a democracy, values for society should be determined by the public. The public, through the democratic process, is more capable of rational action than is the free market, which, due to its imperfections, is inherently irrational. This is a heavy dose of philosophy and logic for the economist to convey to the general public.

What are the effects for natural resources of a private sector that has undue economic and political power to protect its position? It has created a philosophy that what is good for material production is good for the country, and nothing should interfere with this production. The result is a market system in which economic power is reflected, rather than consumer choice, and in which the producer can more easily reflect his values than the consumer. Material production takes priority over all other uses of resources.

A simplifying effect of the market is that all natural resources can be treated as similar or substitutible. The market eliminates the problem of multiple choices in use where one use destroys the other alternatives. This may not be serious in the use of raw materials, such as minerals, that have no end uses themselves. The function of the finished product is important and it does not matter which raw materials are used as substitutes. Resources which have end values in themselves, may be destroyed with no chance of substitution. The problem of extinction, whether of wild area, old forest, or scientifically valuable habitats, is one with which the conservationist is concerned.

Redwoods for wood, redwoods as forest. The forest is not substitutible. Wild area for wilderness, or wild area producing trees and range products are not substitutible. The end results desired, wood and meat can be obtained elsewhere with a little more intensive use. Any resource which has end values in itself, and which does not have to be used up for private production because other non-end use resources are available should not be left to the market for allocation. Its use should be a public decision.

What should a democracy expect from its economy? It seems strange to assume it would permit unguided forces to control the direction and nature of its development. Yet this is what the private sector suggests is the only choice open if freedom is to be maintained.

Given the success that organized science and technology have demonstrated in the fields of material things, it is to be assumed that similar organization for handling social problems might be successful.

There is no reason why we cannot invest the necessary machinery and institutions to make use of our brainpower to establish criteria and priorities for rational use of natural resources for development and growth. This implies greater public interference in the economy, public controls of the boundaries of the private sector to remove the imperfections which are irrational now. This infringement of the freedom of the producer in order to have greater freedom for the consumer majority is hardly undemocratic. Freedoms are not absolutes. They are always being created, developed, redefined through our institutional machinery. The economist should be helping society move in this direction rather than defending the status quo.

In summary, the economist who sticks to the private market for all economic answers has no place in his scheme for conservation with its value judgments and intangibles. He believes conservation is merely criticism of free enterprise, and that desired policy is irrational interference with freedom. This variety of economist cannot communicate with conservationists.

For those economists who go beyond lip service to our two-part economy, conservation is criticism of evident imperfections in the private machinery, or imperfections in the public sector, both of which require corrections through public action. The economist can help by clarifying the causes and effects of these imperfections and their magnitudes and interrelationships to other parts of the economy. He can help by becoming interested in problems with other interested humanists and scientists to move the economy in the direction of its potentials.

DISCUSSION

DR. CAIN [Michigan]: At first I thought that Dr. Banner was fighting the old thing, that of representing the eighteenth and nineteenth centuries. However, as he went on I discovered that he did recognize that there are new sectors of economics, even though they are perhaps incompletely capable of handling some of the problems which conservationists face.

I found his point of the lack of substitutibility as illustrated by the redwood forest versus redwood lumber an extremely sensitive and telling point in his general comment. However, I would like to confront him or anybody else with the argument put forward by Fuller in a book last year—in which he described the characteristics of the private sector of the economy dedicated to consumption as being incapable, by the very structure of business, to accomplish conservation —at least conservation defined in the terms of an economist—that of ready distribution and rates toward the future—which simply means that we should not use them as fast as we can, and then moving on to the subsidiary argument that neither can democratic government practice conservation, because Government is dedicated to a spiral of economic growth over what we call "progress" which is interpreted as increasing per capita consumption and dedicated to full employment, and the whole motivation of the industrial democratic West is toward increased production with no values or understanding of what one would call in the biological field a dynamic equilibrium.

Therefore, when these factors are at work in the psychology of both the private and public sectors of the economy, what could you expect economists to do but what they have been doing—describing primarily those items which are transferable, marketable, transportable?

This is what they have concentrated on and this is the field that they have staked out for themselves.

Therefore, maybe we need a new word that will include conservation—such things as political or social economy or something like that.

MR. VESSEY: I would like to think of what we can do and where we can start to imbue economists with a sense of what conservation is all about.

SUCCESSES, PITFALLS, AND TECHNIQUES IN WILDLIFE TELEVISION

DOUGLAS L. GILBERT

Colorado State University, Fort Collins

Two important questions were asked at the 1959 North American Wildlife Conference: (1) "Can a wildlife television program compete successfully with commercial shows?" and (2) "What problems are involved in inaugurating and maintaining a wildlife television program on a commercial station?" I believe my experiences with a wildlife television program may provide answers.

SUCCESSES AND ADVANTAGES

The popularity of television is common knowledge. According to Chester and Garrison (1956), there are 450 commercial stations and 30 educational stations operating in the United States. Others are planned. Phillips and Rosseau (1959), state that 85 percent of American homes have television sets which operate an average of six hours per day. It is theoretically possible to reach 25 million people with one program transmitted in the vicinity of the Nation's five largest cities. These statistics certainly indicate that tremendous audiences can be reached. It is well, however, to remember that any program can be turned off with a flip of a switch.

In June, 1953, as a Regional Educator for the Colorado Game and Fish Department, I started *Wildlife in Review,* a weekly, 15-minute program over KFXJ (now KREX) radio and television station in Grand Junction, Colorado. This station serves western and northern Colorado, plus eastern and northern Utah. The viewing audience totals 36,000 homes with an estimated 120,000 viewers. This show had a continuous, weekly, program for five years—with the same sponsor. Only recently did the sponsorship change. This one fact, I believe, attests to the show's success and answers the first of the above questions.

If a cost-per-individual-contacted were computed, the figure for television usage would be low. Other advantages of using television in public relations and information work are: people in all walks of life are reached, including both city and rural; the medium holds interest because programs can be seen as well as heard; and timeliness in relation to current happenings can be easily controlled.

PITFALLS AND DISADVANTAGES

One of the first problems encountered was scheduling. *Wildlife in Review* first went on the air as an unsponsored public service program at an excellent time. This time was soon sold to another show—a sponsored one that paid the station for time used. *Wildlife in Review* obtained a less desirable time, and that was again sold. The length of program was cut several times. These events are understandable, because a commercial station is a business and must make money to stay in operation.

The solution was obvious. The Colorado Game and Fish Department could buy the time or else obtain a sponsor. The first possibility was prohibited by cost. The only alternative was to interest a sponsor.

The next question to be answered was, "What sort of sponsor?" A sporting goods store wanted the show. So did a local brewery. Both of these possibilities were turned down. The sporting goods store was rejected because the Colorado Game and Fish Department, a public service organization, could not sanction one store and its products over competing sporting goods stores. The brewery offer was not accepted because, realistically, some people would be prejudiced by the product. The ultimate sponsor was the largest plumbing, heating, and sheet metal business in Grand Junction. They were the sponsor for the entire five year period. Seemingly, we also obtained better station cooperation with sponsorship.

Another closely allied problem was, "Who will do the commercials?" I believe quite surely that usually a member of the sponsoring company or the station should do the selling. In this instance, we did our own commercials. The person presenting the commercials was always out of uniform. Department guests usually wore the uniform.

At one time a situation arose where a local newspaper claimed that the Department was favoring television over the newspaper medium. This problem required delicate handling and an explanation that no preference was intended. The situation was corrected in time, but it could have become a real problem.

By common agreement, the sponsor received three minutes of every fifteen for advertising purposes. This was usually presented in two, one and one-half minute segments as they would best fit into the main body of the program.

There was some difficulty with studio arrangement and timing. For example, we often had three minutes or less to move our equipment and "props" (ranging from aquaria filled with water to live mountain lions and bears) into the studio and to get them arranged. There was also the problem of cleaning up the mess (some were very messy) before the next show could go on. These obstacles were overcome with manpower. Many Game and Fish Department employees helped. Stations with two studios would not present this problem. Kinescopes and video-tapes are other possible solutions since they allow the earlier filming of a show for later release.

It was increasingly difficult to present an outstanding program every time. Repetition in any series of television programs is a poor policy. After a few years many of the better program ideas have already been utilized once, twice, or even three times. This problem may be solved by dividing the responsibility between two or three people. Thus, each person would be responsible every two or three weeks. The Colorado Game and Fish Department is currently trying this solution. It may be effective in offering a variety of program ideas.

The time required to prepare and present a good television program can be overwhelming. As an individual gains experience, he becomes increasingly confident and needs less preparation. The average time spent was about eight hours of preparation for a 15-minute program. This figure includes everything from the hours spent worrying and trying to get ideas for the next show to leg work in assembling the props.

Television is still not the complete answer for all public relations and education work. The audience cannot ask questions directly. There is no personal contact. These factors can be extremely vital if some issue has arisen where personal presentation and group discussion is the best solution.

SUGGESTED TECHNIQUES

Logical steps in presenting a television program were listed by Tonkin and Skelsey (1953). These are supplemented by my findings.

General

1. After "clearing" with your supervisor, make initial contact with the station. One should have a written presentation, in outline

form, of several of the very best program ideas. Wildlife has terrific public appeal and will usually sell itself, but it doesn't hurt to give it a boost. Stress the interest angle and that it will be extremely timely in answering many questions and controversies of the viewing public. Stations want viewers, and television directors are always looking for good material.

2. Decide on the time of presentation and the length of the program. Realize that you may have to start with a not-so-desirable time and work up. If you produce a good show, the station will arrange a good time. *Wildlife in Review* settled in a 6:45 to 7:00 p.m. time on Tuesday evenings. It followed regular sports and preceded the news. I think this was ideal. After trying several half-hour shows, we decided that for a continuous run the 15-minute program was better. For single shows, or for programs in a short sequence, a half-hour show would have marked advantages.

3. One should solve the problems of a sponsor and commercials as soon as possible. All persons concerned will feel better when the show has a definite air time and running period.

Specific

1. In developing an idea for a program, it is good to work from a Departmental calendar. It is possible to have interesting presentations and at the same time to sell your Department and give it much excellent publicity. Correlate your programs with seasons. For example, we usually tried to schedule a program on bighorn sheep a week or two before the bighorn season.

Programs can be arranged to explain a new law or regulation to the public. For example, new tagging regulations can be discussed before the big game season. It is easy to see that one or several TV programs can be an extremely important asset to any wildlife department in disseminating important information and instructions.

Keep in constant touch with your superiors. They will often want to start the "selling program" for a certain problem or proposal long before that particular situation is known to the public.

2. Decide what you want to accomplish with a given program. Picture the show in your mind. Visualize what you are going to show and say. Then write it down. One suggested way is to draw a line down a sheet of paper one-third of the width in from the left margin. Use the left one-third of the sheet for the video notes (things you will show). The right two-thirds can then be used for the audio portion (that you will say). This latter should be only in outline form.

3. Discuss the show with the station director. He knows the studio

limitations better than anyone else. I suggest indoctrinating him slowly. Use fish and docile wildlife before dropping the lions, bears, and skunks in his lap.

4. Collect your materials and data. Don't overlook personnel. Check and double check whom you need. Be sure they appear at the right time.

Choose your visuals or props carefully. They can make or break the entire program. According to Schild (1954), visuals accomplish four things. They hold attention, create interest, increase understanding, and increase retention. It is possible to have too many props and only to succeed in cluttering the set. The object being discussed is usually the best prop you can obtain. Models have the advantage of being smaller and may often be readily taken apart. Live graphics, such as line drawings or use of a flannel board, can be very effective. I have used a "strip tease" with success. Here the drawing or object is covered with strips of paper which are removed as points are stressed.

Motion pictures, slides, and black and white photographs can be used very effectively on television. There is a tendency, however, to over-use motion pictures. Although they make possible the viewing of creatures and scenes that cannot be shown "live" on television due to time, size, or distance, they do not have the effectiveness of a live program. Film clips, short sequences that are narrated in the studio, are particularly effective. Most studios prefer 16 mm. film taken at 24 frames per second. All motion pictures to be shown on TV, whether sound or silent, should be taken at this speed.

Several large corporations make available good outdoor movies which can be used on television shows. However, some of these are so badly cluttered with the corporation's product that they are not suitable for use because of impromptu commercials. All commercial films should be previewed to see if they contain too much advertising or any advertising which may be objectionable. For example, a film showing one make of truck performing difficult feats in a hunting camp might be objectionable to another automobile company (especially if the second company is sponsoring the program).

All motion picture films should be pre-viewed before use. Those found to be badly scratched or having torn or badly worn sprocket holes should be rejected.

If you plan to use slides, be sure to check the station equipment. Check the types of slide mounts their equipment will accept. If possible, all slides should be mounted in glass for protection. Slides a little on the light side are better. Television seems to darken the effect. Keep your slide sequence moving rapidly. About four to six slides per minute is best. *All* films and slides to be used should be thoroughly previewed before showing. Carelessness is the only explanation for upside down slides.

Most television stations have equipment which will handle opaques. These "large slides" are approximately 3.5 by 4.5 inches and allow written, drawn, or typewritten material to be shown.

With posters or black-and-white pictures, use a size ratio of three units high to four units wide. You will lose about ten percent around the edges, so concentrate important points in the center. Make pictures large enough to be seen easily. For this purpose it is best not to use photographs smaller than 8 by 10 inches although 5 by 7's can be used. Matte finish prints will not reflect the light and cause glare as will glossy prints. A good practice is to tilt the top of the picture or poster slightly outward. This will cause the light glare to be pointed down and not into the camera.

5. Two rehearsals before the actual presentation are ideal. A walk-through or "dry-run" rehearsal need not even be in the studio. It is wise, however, to hang up a tin lid or paper to represent the camera. Be sure you and your guests become accustomed to talking to the camera when not talking to another person. If two cameras are used, the "live one" will have a light on it. This preliminary rehearsal affords a chance to check the pace, take a rough timing, and most important of all, it gives the guests a chance to become somewhat familiar with procedures, including cues. As a result, everyone will be more relaxed during the regular show.

A dress rehearsal incorporates the use of all equipment and individuals exactly as it will be on the air. This rehearsal is used for accurate timing, for tailoring, adding, and subtracting. This is the time to detect, and correct, all errors. For example, the door on a deer trap may stick. It is far better to have it happen during a rehearsal than on the air. The dress rehearsal should not be concluded until everything is exactly as it should be.

Many large television shows have a camera rehearsal in addition to the two already mentioned. This is usually impossible due to individual time as well as station time. You will probably have more shows going on the air without any rehearsals at all.

6. Present a copy of your final outline to the director of your program. Indicate your proposed movements as nearly as you can predict them. I found that very few shows went exactly as planned. deadly to the program. Interviews are good in that they take less preparation, for an expert is helping, and there is a change in voices and faces for the audience to hear and see. An occasional round table or controversial discussion is good. Spot news announcements

Wild animals are very unpredictable, and anything can happen! Actually, there are three kinds of wildlife television programs. The kind you plan, the kind you do, and the kind you wish you had done after the show has been televised (Hoover, 1959). It should, however, be possible to give an accurate listing of sequences and materials to be used.

Our better shows were often those where the unexpected happened. Regardless of how calm you think you are, the animals can still sense your nervousness and anxiety. Tame animals often revert to their true, wild nature. In one instance the topic involved skunks, and a docile, descented pet was used. This pet skunk bit my finger to the bone. I pried his mouth open with the other hand, and he bit another finger to the bone. Blood was gushing, but the audience thought the show excellent!

7. To stay in good graces, the studio should be cleaned up immediately after the program. This may involve only simple straightening or moving out, but it may also involve mopping the floor or some operation that takes more time. Do not leave the cleanup for the floor manager, the camera men, and personnel of the next program.

8. Any television show should involve one more step, the "follow-up." You should hold a "post-mortem" of the program. Did it accomplish what you wanted? Did it incite questions and discussion? What were its good and bad points? Keep complete notes on each program. This will help you to avoid repetition, aid you in case you want to repeat the program, and will provide you with a permanent record you can use time after time.

Miscellaneous Hints

There are many additional suggestions that can be mentioned.

1. Keep the introduction and announcements as brief as possible.

2. Use much of "Show How" and little "Tell How." Our best type of show was the demonstrative kind. An amateur lecturer is are especially applicable and timely during hunting seasons or to promote special programs, such as hunter safety.

3. Go out of your way to make friends with station and Department personnel. Absolute cooperation is necessary. A program can be made or broken by the cameramen.

4. Always attempt to have the correct attitude. Be interesting, cheerful, personable, sincere, alert, friendly, informal, and always yourself.

5. Watch the time closely. Know exactly how long your closing remarks will take. This way you can end right on time.

6. Talk slowly, even more so than on radio. Try to keep your

conversation simple, frank, and convincing. You do not need to project.

7. Remember, you must *entertain* as well as educate. Your audience can always turn to an adult western.

8. Let the studio staff take the responsibilities they are supposed to. Do not tell them how to do their job.

9. Have a specific rather than a general subject. Develop one idea well rather than skim over a broad subject or lightly touch on several topics.

10. Use a minimum number of props. Keep the program simple, yet effective.

11. Start the program with an ''attention getter.'' This may be a shot of a live animal, some other unusual visual, or an intriguing question.

12. Have some ''cushion'' material. This can be included or left out depending on how the time is going. News releases are excellent for this purpose.

13. Move slowly at all times so the camera can follow. Think of the camera as being a person watching you.

14. Never show an object less than 30 seconds. The viewing audience requires that long to be fully aware of the object.

15. Do not obscure objects you are showing with your hands or body.

16. Check clearances and copyrights for all materials used. This includes photographs, films, maps, and music. Some educational films, in addition to requiring special clearance, may not be used on shows which are preceded or followed by shows on which alcoholic beverages or tobacco are advertised.

17. Avoid large areas of black and white with clothing. This creates a ''halo'' around the area. Blues, grays, greens, and yellows are better than blacks and whites.

18. Limit the number of people in any scene to two or three. More than this gives an impression of disorder and diverts attention.

19. Do not ignore obvious accidents. They may liven up the show.

20. Do not over-use gestures.

21. Dress correctly for the occasion. For example, if you are showing how to skin a deer, do not wear a suit, white shirt, and tie.

22. Have one, spare, complete program in readiness at all times in case key personnel do not show up or collapse from fright.

23. Results are hard to measure. Telephone calls and letters give only a rough index. One possible gimmick is to offer a free piece of literature.

POSSIBLE PROGRAMS

The following list includes some program suggestions that might be used. If possible, correlate the programs with game and fish seasons and happenings in your state. Realize, however, there will be a period of virtually no seasons. Then ingenuity will be taxed to develop good ideas and programs. A partial list was published by Gilbert (1956). Those after number 50 are from Hoover (1959).

1. Live trout in aquarium. Caught trout (15 to 24 inches) in dip net. Discussed size, weight, identifying characteristics, where found, and other points.

2. Live warm-water fish in aquarium. Procedures as Program No. 1.

3. Pheasant mortality factors. Showed flushing bar, explained operation. Discussed role of predators such as skunk and magpie. Props included young pheasants, old pheasants, broken eggs, and naturally hatched eggs. Slides were used to show effect of mower.

4. Slide show on fish planting.

5. Electro-fishing. Showed how AC and DC shocking systems work on small, live fish in aquaria. Showed how fish are attracted to one pole and repelled by other.

6. Live bobcat. Discussed life history and other factors. Although animal was tame, had to give it a bottle of milk to be able to point out identifying characteristics.

7. Deer fawns. Discussed camouflage, loss of spots, picking up fawns by general public, and tagging operations.

8. Bighorn sheep. Props included large and small ram heads and ewe head. Discussed aging and sexing techniques, why a bighorn season, and what constitutes a legal ram during the coming hunting season.

9. Grouse season. Talked about regulations, the coming season, and why the Department should have a season. Identification stressed. Props included study skins of species involved.

10. Antelope. Show timed to correspond with approaching season. Problems covered included methods for license application, sex identification, and tagging legalities. Used mounted head and 8 x 10 pictures on antelope trapping.

11. Turkey show. Correlated with coming turkey season. Discussed identification of wild birds, best areas to hunt, weights and sizes, uses and misuses of turkey call, rules and regulations.

12. General big game program. Points included: why have different seasons, how seasons are set, game damage or problem areas, best hunting areas, public and private land controversies. Had big game

map and licenses available. Covered rules and regulations of coming season.

13. Dressed, skinned, and cut up a deer. Covered techniques involved.

14. Slide show on deer problems in Colorado besides hunting. Stress was on starvation if adequate harvest not obtained.

15. How duck seasons are set. Had flyway charts, migration charts, and study skins. Gave duck call demonstration. Discussed decoys and their use.

16. Coming pheasant and quail seasons. Covered rules and regulations. Had live birds for species and sex identification. Stress was on courtesy toward the land owner.

17. Trapping and banding operation of ducks. Had live birds to band. Discussed why band, information obtained, methods of trapping. Had trap models.

18. Live coon and badger. Covered food habits and other characteristics.

19. Fur program. Covered methods of skinning and stretching, prices, trapping regulations and techniques. Had collection of furs as props.

20. Spawned fish. Showed all phases from taking the spawn and fertilization process to packing for shipping. Received telephone call from irate mother that little girl had tried to spawn the goldfish and killed them.

21. Horns and antlers. Covered difference, how grown, how shed, methods of aging, records, and abnormalities.

22. Film on big game census work from airplane. Was narrated in studio. Brought out reasons for count, data obtained, best time, and danger of operation.

23. Live opossum. Covered life history and habits. Used two slides showing young in pouch.

24. Film on the beaver.

25. Live mountain lion. Covered life history points, including food, trapping, voice, and value as predator. Tried to get in some telling points on the bounty.

26. Live beaver. Discussed season and regulations. Showed materials and techniques involved in trapping and skinning.

27. Pointed out identifying characteristics of game species based on skulls and feet. Had collection of both. Covered tracking and track identification.

28. Magpie problems. Discussed values. Had live birds and model of group trap. Had talking magpie on program.

29. Mink. Local fur rancher displayed color phases. Showed size

differences. Discussed mechanics of operation and comparative values.

30. Raptorial birds. Used study skins to point out identifying characteristics of buteos, accipiters, falcons, and harriers. Discussed protection and value.

31. Live trapping and tagging deer. Had model of deer trap and live deer in carrying box. Tagged the animal. Discussed reasons, where done, different tags, trapping operations and results.

32. Live half-grown, brown bear. Discussed characteristics, and habits.

33. All about traps. Had all sizes and types including No. 5 bear trap and Hancock beaver live trap.

34. Squirrel show. Types found in Colorado, life histories, habits, and laws governing. Props included study skins and slides.

35. Rabbit show. Same points as in No. 34, only for rabbits.

36. Wildlife photography with Game and Fish Department photographer. Covered camera types applicable, lenses, film, and the use of blinds.

37. Chukar partridge—Colorado's new game bird. Covered history, description, characteristics and habits, and work being done to establish it as a game bird. Had live birds and models of "gallinaceous guzzlers."

38. Ring-tailed cat. Discussed characteristics and habits.

39. Film on grouse strutting and booming activities.

40. Care of fishing tackle and tackle repair. Reviewed laws and prospects for coming season.

41. Fly tying demonstration.

42. Cooperative show with United States Forest Service. Discussed fire building and suppression, care of campgrounds, litter bugs, and water pollution.

43. Film on fish hatchery operation.

44. Fish planting from the airplane. Used 8 x 10 photographs supplemented by miscellaneous props such as oxygen tablets, aereating device, and drop buckets.

45. Fish poisoning. Covered reasons for such an operation. Used a large aquarium containing fish. Also discussed fish clipping and tagging operation and reasons.

46. Fish foods. Show involved much camera closeup work to show natural foods (insects and larvae) which are eaten. Talked about hatchery foods.

47. Amphibian program. Had salamanders, toads, leopard frogs, and bull frogs. Talked about characteristics including metamorphosis, foods, enemies, and habitats. Discussed seasons and methods of hunting.

48. Controversial brook trout issue. Why have a more liberal season on brooks? Results of research and work being done on the problem. Pointed out identifying characteristics of the species. Showed stunted and large fish.

49. What youngsters can do in wildlife work or nature work with two small boys as guests. Had their insect collections and plant collections. Talked about scouts, scout work, and pets they have had.

50. Snakes. Difference between poisonous and non-poisonous snakes. Milked a live rattlesnake. Showed treatment for snake bites.

51. Bighorn sheep lung worm. Subject discussed with research biologist. Used microphotography slides.

52. Lizards. Showed live specimens of local lizards (7 species). Talked about their natural history.

53. Gun safety. Demonstrated safe gun handling and discussed the ten commandments of safety.

54. Archery hunting. Showed types of bows and arrows used in hunting. Discussed hunting techniques and demonstrated the power of a hunting bow.

55. Taxidermy. Had a local taxidermist show the steps in mounting specimens. Showed poor examples of handling the trophy in the field. Discussed how to prevent such errors.

56. Live foxes. Had both red and grey species. Covered characteristics and habits.

57. How not to get lost while hunting. What to do if you should get lost.

58. Hunting dogs. Had trainer and several species of hunting dogs. Covered particular values of each species.

59. Duck dressing. Demonstrated how to dress a duck by dunking the duck in boiling water containing a detergent to cut the oil in the feathers.

60. Question and answer session of questions submitted by the public.

61. Buying a youth his first gun. Recommended a .22 single shot rifle. Covered care and methods of teaching a youngster gun handling. Suggested joining youth gun club.

62. Porcupine. Had live specimen. Reviewed natural history and demonstrated how to pick up with bare hands. Discussed damage to the forest.

63. Vanishing wildlife species. Covered reasons for virtual extinction of grizzly, prairie chicken, wolf, wolverine, otter, bison, black-footed ferret, and lynx in Colorado. Had skull, skin, foot or drawing of each animal.

64. Back packing. Showed right and wrong things to take on a

three-day pack trip to the high country. Demonstrated comparative weights of two packs due to their contents.

65. Turtles. Illustrated species in Colorado and covered their natural history.

66. Emergency first aid. With physician as guest, covered causes, precautions, and first aid for heart attack, stroke, hemorrhage, fractures, and shock. Demonstrated splinting and transportation of victim on improvised stretcher.

67. Hand loading. With local hand loader as a guest, showed tools and demonstrated techniques. Mentioned safety and costs.

FUTURE POSSIBILITIES

The tremendous importance in wildlife work of having an informed public is realized by all. With increasing human populations and eventually decreasing wildlife numbers plus presently decreasing wildland areas this importance will become even greater.

We are approaching a new era of species management for certain species, especially waterfowl. Perhaps the time of a required examination to obtain a hunting license is just around the corner. Due to human population increases, we may eventually have to "un-sell" some of the liberal seasons and bag limits we have worked so hard to sell. Television will be used more and more by Game and Fish Departments to further these necessary objectives and to promote good public relations when these and other management changes become necessary.

ACKNOWLEDGMENTS

I express my sincere appreciation to the Colorado Game and Fish Department by whom I was employed while doing my wildlife television work. If it had not been for the personnel of the Department, most of the shows would not have been possible.

Bob Hoover of the Colorado Department became responsible for the program when I left for other employment. Some of the included, suggested programs were his ideas. He also read and commented on the manuscript.

Mr. Farley Tubbs, deputy director, Michigan Department of Conservation, Information and Education Division, rendered invaluable aid in reviewing and constructively criticizing ths paper.

Doctor Warren W. Chase, Doctor A. B. Cowan, and Professor Edward Stasheff of the University of Michigan; Doctor Harold W. Steinhoff and Professor J. V. K. Wagar of Colorado State University made many worthwhile suggestions and comments on the paper.

Lastly, my sincerest thanks are due Lane and Company, Plumbing,

Heating and Sheet Metal Firm, to radio and television station KREX, and to the great many television viewers in the area around Grand Junction, Colorado.

SUMMARY

1. Findings reported were the result of experience gained in conducting *Wildlife in Review,* a 15-minute, weekly, television program, which has had the same sponsor for five years.

2. A sponsored program has definite advantages, including stability, compared to a public service program.

3. Many problems are discussed, including choice of sponsor, sanctioning one business over another, sanctioning one media over another, the handling of commercials, studio arrangement and timing, and pressures and time involved.

4. Eight logical steps are presented as a guide to presenting a wildlife television program. Miscellaneous hints are also given.

5. Sixty-seven suggested programs are listed.

LITERATURE CITED

Chester, Giraud and Garnet R. Garrison
1956. Television and radio. Appleton-Century-Crofts, Inc., New York. 652 pp., illus.

Gilbert, Douglas L.
1956. Television as a wildlife education medium. J. Wildl. Mgmt., 20(4):456-458.

Hoover, Robert
1959. Personal correspondence. Colorado Game and Fish Department.

Phillips, Robert L. and Roland F. Rousseau
1959. The use of Radio-TV by state wildlife conservation departments. J. Wildl. Mgmt., 23(2):235-237.

Schild, Donald T.
1954. Visuals for TV. The First NAEB TV-Production Workshop. Urbana, Ill. 4 pp. (Mimeo.)

Tonkin, Joseph D. and Alice F. Skelsey
1953. Television for you. A handbook for extension agents. USDA. Ag. Handbook No. 55., 24 pp., illus.

DISCUSSION

MR. VESSEY: I am sure you will agree that Mr. Gilbert has given a very thorough exposition of his subject. Knowing something about what it takes to prepare and stage a television show, I can only congratulate Mr. Gilbert and the State of Colorado for their initiative in putting on a program of that nature.

MR. SELKE [Minnesota]: Have you a single program for the state as a whole or the department of conservation or is it carried on in connection with the division of wildlife or something of that nature? Do you have, in Colorado, several stations where these programs are presented?

MR. GILBERT: I think that most everyone realizes that the State of Colorado is administered under a regional setup. We have four regions in the state. In each of these regions we have a regional educator and, for the most part, I would say that each regional educator does some television work.

For example, we have television shows out of Grand Junction in the Northwest; Denver in the Northeast; Colorado Springs in the Southeast, and Montrose in the Southwest.

MR. SELKE: I sensed that. Do you coordinate between the different sections of the state for the different regions? Do you have an over-all state program as well as a regional program?

MR. GILBERT: Yes, we do, and this is coordinated out of Denver.

MR. SELKE: Could you give us a little information on total costs of your television program in Colorado, on a local as well as state-wide basis?

MR. GILBERT: I might say here that for the last two years this program that I have been discussing this morning, has been under the jurisdiction of Mr. Hoover because I left for other employment. However, when we first started the show in 1953, the cost for a 15-minute program was in the vicinity of $100.00.

MR. VESSEY: Do you have any idea of what it costs the sponsors?

MR. GILBERT: That $100 figure, per 15 minutes, is the cost to the sponsor. That is exclusive of cost of department personnel, their time, as well as the time of other individuals.

MR. LAMB [New Mexico]: I was wondering if you had any idea of the over-all cost to the department for a year's program? You mentioned 8 hours of preparation time for a show. However, there would be other general costs.

MR. GILBERT: I am sorry, Sam, I will have to say "no" to that. I think it should be done but we simply have not done it.

MR. VESSEY: Farley Tubbs says he has some figures on this.

CHAIRMAN TUBBS: We have had a television show pretty much like that of Colorado but operated on a slightly different basis. We have put it on over an educational television station—that of Michigan State University.

We make five copies of the Kinescope of each show and these were shunted around as programing was advantageous to thirteen stations. Therefore, we got pretty good coverage over all of Michigan.

In the preparation of the television copy, there is the first copy, the Kinescope. That was an expenditure that was made in connection with Michigan State College, Michigan State University. Then we had to have the Kinescope copied in order to send them to the different stations.

Adding all of this up, the cost per week runs close to $400 or for the year, we budgeted around $15,000 for the television show, aside from personnel costs.

We kept that down to that figure largely by using reruns during the summer months, and late summer months. That would be the time during which our television producer would have been on vacation and so on.

EMERGING GOALS FOR RESOURCE-USE EDUCATION

GEORGE L. FERSH
Joint Council on Economic Education, New York City, New York

I would like, in the time allotted to me, to explore with you some observations that I have gathered of the trends as I see them in conservation education.

In the first place, I see a trend for support being sought for conservation education on a more widespread basis and for much more significant reasons than ever before.

The teachers who are asking for conservation in the schools are not just people who happen to like the outdoors, but people who see this as a fundamental part of general education of every single youngster in the United States. They come to this realization, I think, because they recognize certain things about conservation and natural resource problems.

In the first place, they recognize that we are dealing with the fundamental problems of mankind—what the economists call the economic problem. How do you balance the limited resources which we have with the unlimited demands which we make upon them? In thinking of this, we should think not only in terms of the national demands but the phychic demands as well.

Teachers also recognize that this has a very important part to play in American education, particularly, because in our type of society we uniquely depend upon the individual to make decisions on how best to allocate these limited resources in order to meet unlimited demands. This is not the case in all countries of the world. In fact, very few countries in the world permit this to the extent that we do. However, since we *do* permit this to happen, since we *do* depend upon individual decisions to let us know how to allocate the resources, it behooves us to have an educational system that trains our people to make those decisions wisely; because without it, our entire economic system does not respond in a way that makes the best use of our resources.

Furthermore, teachers today recognize that when we talk about resource problems and resource decisions, we are dealing with a problem that is more urgent than ever before in our history and in the history of the entire world.

All you need to do is to note the population developments taking place, both within our country and throughout the rest of the world, to realize the significance of decisions affecting the available resources. When we talk about population, we must not only think in terms of numbers of people, but we must also think in terms of trends in population locations; and we must think in terms of the trends of population composition. Each of these trends has significance for the decisions that we make concerning the resources of our nation.

We recognize this problem as being urgent in addition to population growth, because we see throughout the world expectation for rising living standards on the part of people who have been content with a limited standard of living but who are now demanding far more. As a result, there is going to be increasing pressure upon the resources of the entire world. To a large extent, we are going to be denied resources we have been accustomed to from other parts of the world. As these people demand resources to raise their own standards of living, they bring to our attention the problem of what we do with our own resources. Therefore, we have to look ahead to the future, and the availability of the resources we depend upon.

In addition, it is urgent because we face competition throughout the world; competition in world markets for the sale of our goods and in getting resources for ourselves, because other nations are competing very successfully with us. They are making decisions concerning their resources which enable them in many cases to undersell us and to corner markets. As a result, the resource problem is a very urgent one.

Then of course, the dark cloud of war hovers over us and this also gives urgency to wise resource decisions. The tensions of possible war alone are causing us to stockpile resources. Just think of the catastrophe that might come to us from war and you realize that we had better make wise decisions about those resources that are available to us now, so that if war wipes out much of what we have constructed, we nevertheless will find it possible to rebuild our civilization.

In addition to this urgency, teachers are recognizing that we are dealing with a problem more complex than ever before. When you think of the acceleration of science and technology, you know that there are no ready answers to the resource problems, for we cannot know today what we will have available to us in the future. Energy developments may make it foolish to think of conservation practices with regard to fossil fuels. Recent biological developments have a tremendous impact on what the future might bring.

What I am saying is that things like climate and weather control, and other scientific probabilities, are introducing new elements that make this whole area extremely complex.

In addition, we have the possibility of new resources that we can call upon. We think of excavations that might be made through the use of nuclear energy and what this might do to our mineral supply. Therefore, when dealing with this problem, you have to have an open-ended approach to it.

The problem is also complex because of the tremendous move toward urbanization now taking place in this country. Let me give you one figure that, in a sense, sums up this problem and what it might mean to us with regard to our resources.

By the year of 1980, it is estimated that 80 per cent of the people of the United States will be concentrated in 80 metropolitan regions. Here you get put into perspective the nature of the new kind of resource problem as more and more of our people are concentrated into these limited areas. This will put an increasingly greater burden upon outside areas in order to feed them, and to provide their other needs. However, it will also put a greater burden upon the people within cities as to what to do with resources within their cities so that they can have those satisfactions that most of us would want them to have.

Such things as automation will bring new vistas into being regarding resource use. What will this mean in terms of leisure time that people will have and what will available leisure time mean to the resources which people will need to satisfy their lives? These then are reasons that teachers are now saying that conservation and resource-use education should be a fundamental part of the general education of all the students of America.

As I go throughout the nation, I see a trend toward a broadened scope, a broadened definition of conservation and resource use. While it is true we still must teach a great deal about the renewables, I find that trends throughout the nation are also moving in the direction of teaching far more about our mineral resources and far more about our energy resources, because these play a much greater role in the way of life of the American people than they ever did before. Therefore, conservation education must be aware of the fact that this is so.

Teachers are dealing not only with the conservation aspects of minerals and energy, but they are also dealing with the developmental side—with steps necessary to make the best use of our minerals—with processing, and so forth; with the way in which we must take initiative to harness our rivers to get energy; with the recognition that all resources are neutral until man takes some action with regard to them and makes them useful for him.

I find also a trend in conservation and resource education to move not only in the physical sciences but to move forward toward the social sciences as well. We find teachers dwelling upon historical significance, the way in which historical leadership has been determined, and the way people have handled their resources.

I find that teachers of economics are bringing far more to young people about alternatives—how we must choose between alternatives in order to make the best use of resources, and choose between present use as against future use. This is what economics is contributing.

I also find much more being done in political science. Students are becoming acquainted with legislation and their own possibilities for having an impact upon resource use through their government—using government in a positive fashion rather than as a negative, restrictive organization.

Conservation education is moving from agricultural into urban problems. Teachers are saying that when you talk about zoning and planning, the use of space within cities, you are also talking about resource-use education; when you talk about air pollution and water pollution, these are all parts of resource-use education; that as you think of the wisest sites for recreation within cities and in the environs of cities, there is also a part of resource education involved.

I also find a trend toward broadening the geographical interests of students. They are not only concerned with local problems, but they are beginning to think regionally about their resources; they think nationally about their resources and they think internationally about their resources. They realize that what happens with regard to imports and exports in other nations affects decisions within our own country with regard to resources available to us, and that knowledge we obtain from other places is of equal significance to knowledge we might be able to obtain through known sources within this country.

I find also a trend away from the production side with regard to resources toward ample consideration for consumption, because we are penny-wise and pound-foolish to think only of what we are doing in production of resources and not pay attention to educating our people to consume those resources in the wisest possible way.

Another trend is toward broadening methods used in conservation education. Not only are teachers taking youngsters out to work with nature, to feel nature, but, more and more teachers are engaging young people in the mental exercise that is necessary to make wise decisions concerning resources. They are learning through problem-solving experiences, in which they investigate resource problems and define them and do some research and, at the same time, think of alternative decisions that might be made, and then take action.

I find also a difference in the kind of field trips teachers are conducting, not only taking students to agricultural sites but more and more to industrial sites, to see whether wise use is being made of resources there. They are taking them to sewage plants and municipal areas, and this is another important part of resource-use education.

There is another trend and that is toward broadened participation in the field of resource-use education. More and more school administrators are being attracted to the significance of this, and this is all to the good, because teachers cannot do much unless they get the support of school administrators. I find that this base of teacher participation is much broader than ever before—that teachers of all subjects are making contributions, not only in the physical and social sciences, but also in the arts and the humanities. They are bringing a depth of understanding to this field that they had not brought before.

Teachers of all grades are participating because the concept is that they should begin at the first grade and go on up through high school and even into our colleges.

I find a trend toward a greater emphasis on conservation education in teacher training institutions over the nation and, of course, this is good because it is almost futile to think of trying to retrain all of the teachers that we have. I also find in-service programs being put on throughout the nation for teachers who are already experienced.

There is also another more significant trend and that is that more and more councils are being organized on the local and community level, as well as at the state level, where people such as yourselves are brought together to exchange ideas with educators and, in that way, to develop an all-around program to suit the needs of the people within each state.

Now then, what do these trends mean?

It seems to me that what you should recognize is that we advocate conservation and resource-use education and that you should advocate it on a much more broadened justification than you have in the past; that you should relate it to the survival of our people, to their efficiency, to the values of our economic system. You should relate it to the urgency of the international situation.

These are the kinds of things you should stress as you talk about conservation and resource-use education in the schools.

Furthermore, it seems to me that as you train people for conservation education responsibilities within your own agencies, that these people should be trained with a much more broadened outlook than perhaps they have been trained up to this time. It seems to me when you put on workshops for teachers or when you participate in workshops, that you should recognize that you should broaden yourself out to include within your workshops all the kinds of things that I have mentioned.

It seems to me that when you prepare materials for students and teachers that you should bear in mind this newer emphasis which teachers are willing to include within the schools, so that your materials do not end up in the wastebasket because of a parochial or limited point of view. The materials will be used when they are related to what the teachers consider to be important.

It seems to me, also, that you should do as much as you possibly can to participate in the work of the councils that are being organized in the communities, in the counties and in the states throughout the nation; that if such a council is not yet in existence, that you should take the necessary time to move ahead so that such a council is organized.

DISCUSSION

MR. VESSEY: That was a very thought-provoking presentation. I would like to direct attention to the very great job we need to do in education with agencies, particularly with agencies working in this field of conservation.

My own observation is that we need a lot of education within these organizations who are providing the leadership. There should be a lot of discussion generated by this paper.

MR. WEIL [Washington, D.C.]: I was a little amazed and puzzled by Mr. Banner's statement that most economists were not interested in conservation. I must admit that Dr. Fersh seemed to be talking the kind of language that economists I know like to hear. Therefore, I would like to compliment him on that.

MR. SELKE [Minnesota]: As an old school dad, I have not bled for conservation as the speaker has, but conservation, of course, is a growth within the school systems, especially as far as curriculum is concerned. One of the things that should be pointed out, and I think intimated, is the tendency to understand that children, at a much more tender age than we originally thought, can understand many of these problems. I remember when men like Clyde Croxton, for example, pointed out facts that science could be taught even in the early elementary grades, and that the children merely needed to be exposed to it.

I remember the illustration that they used in those days. George Washington knew nothing about automobiles; and Abraham Lincoln wasn't interested in airplanes. In other words, children have to be exposed to these things before they can acquire interest in them.

I am also glad that you have stressed the point that the teacher training institutions are understanding that this is a part of the background that each teacher should have. I actually feel that this is one of the greatest movements that we can have—getting hold of the people who are to be the citizens of tomorrow and attempting to make them understand these things.

I remember one day making a survey at a penal institution. This was many years ago. I remember that I pointed out the fact that what they needed in this penal institution was education and then the warden said, "Yes, the inmates do." However, I stopped him and I said, "I don't mean the inmates—I think the people who take care of the inmates are the ones who need education most."

I also feel that a part of this educational program should be directed at the state department of conservation—at the United States Forestry Service, the park service and especially, perhaps, at the NAM and the United States Chamber of Commerce.

MR. FERSH: I have just one brief comment, in connection with teaching this sort of thing to young people.

We firmly believe that you can teach economics in the first grade and relate it very closely to the whole matter of resources. As an illustration, I often will say to a teacher or even to a class when I go into the first grade—invariably on the school grounds, there will be a tree out in the front and as a result, you can engage these youngsters in a very serious discussion to the effect—"this is a tree, this is a resource made available to us. Now, what use shall we make of this tree? Shall we use it for shade; shall we use it for beauty; shall we use it as a place for birds; shall we use it for the purpose of soaking up excess water, for the purpose of holding the soil together or shall we chop it down? Further, if we chop it down, shall we use it for pencils, houses, and so forth?"

This is the whole question of economics—the alternative uses we have for the resources and I believe that a lesson like that, even in kindergarten and the first grade, can be quite helpful and have a deep impact on the youngster for the rest of his life because, as he sees these resources being used, he becomes critical. Therefore, I feel that you can do a great deal in this direction.

MR. VESSEY: I speak with considerable feeling about the need for education within my own organization. I also am sure that I could expand this to other organizations who are running this show—the Wildlife Management Institute and the Wildlife Federation—all of them up and down the line.

KEEPING THE CHILD IN TOUCH WITH THE EARTH

ALFRED G. ETTER
Department of Fisheries and Wildlife, Michigan State University, East Lansing

A celebrated exploit of Hercules was his victory over Antaeus. Antaeus, the son of Terra, the Earth, was a mighty giant and wrestler, whose strength was invincible so long as he remained in contact with his mother Earth. He compelled all strangers who came to his country to wrestle with him, on condition that if conquered (as they all were) they should be put to death. Hercules encountered him, but finding that it was of no avail to throw him since he always rose with renewed strength from every fall, he lifted Antaeus up from the earth and strangled him in the air.

Like Antaeus, a conservation-wise people must be in touch with the earth. Yet our new urban way of life, like Hercules, threatens to separate us from our source of strength. Through no fault of its own, our new generation is being born and brought up in virtual ignorance of the natural world. I am afraid that in the near future our plea for the importance of wildlife, natural landscape, and natural principles of land-use may well fall on indifferent, if not deaf ears. In a recent talk with a friend about this he said that in his mind the teaching of ecology to city-bred people presented as many problems as trying to teach atomic physics to the average citizen. It is like trying to get someone to visualize a forest when he has never seen a tree.

Does this mean that we conservationists must fold up our tents and disappear into the desert? In my weaker moments I must confess I have felt so inclined. There seems to be no way to stem the tide of urbanization nor to change the city into a place which preserves some of the inspiration of nature. The human irruption shows no sign of stopping until it has destroyed its environment. I have heard figures that say we are bulldozing 3000 acres of metropolitan land every day of the year. These are the corner lots, the woods across the street, the old farms, and the river bottoms where the kids used to play. Wildland out of town is divided into smaller and smaller tracts, developed, posted, fenced and polluted. Potential park areas are disappearing rapidly.

Yet the more we need parks and playgrounds, the more we destroy the ones which exist. A city needs a new throughway. Where does it go? Through the park. State parks are being converted into recreation areas, and recreation areas are becoming neighborhood playgrounds, and playgrounds are becoming parking lots. The Metropolitan Parks Authority of the Detroit area reports constant demands for more intensive use, children's playgrounds, sandpiles, shuffleboard, etc. The latest thing in Detroit playgrounds is described thus: "A multi-colored fence, with sections alternately bright red, blue, yellow, and orange, surrounds the area. Enveloped by children stands the 'fun monster.' Concrete slabs have been bolted together to form the sides and top. Standing just beyond is a pinto horse, complete with painted saddle, bridle, tail, and tractor tire legs. Youngsters are crawling over and through gaily painted lengths of sewer pipe." I compliment the imagination of the creators of these facilities, but I cannot help thinking of Professor Leopold's remark, "I am glad I shall never be young without wild country to be young in."

This is the change that conservation has to face. We have gone from wilderness to fun monsters, and yet we have greater resource problems to solve than ever before. Wilderness is self-perpetuating. Civilization has to be maintained. That is the crux of the problem, and these children aboard the tractor-tire horse are going to be faced with the job. Can they do it? What can we do in conservation-education to help them?

Leopold yearned for the development of an "ecological conscience" as an ultimate goal. Today, 20 years later, we not only have no ecological conscience, but we have no conscience at all among a surprising group of our citizens. More and more as parents struggle with problems of security and competition, they relax their moral concepts to include very mushy interpretations of what moral behavior is.

A respect for life was implied in the concept of an "ecological conscience." How much respect for life is taught today? In our feverish way, we incite students to go into science, and what do we teach them of life? How to dissect it, change it, kill it, use it—everything but how to appreciate it.

An "ecological conscience" also implies a knowledge of life. What knowledge do people today acquire of life? Buried in an avalanche of semi-authoritative information illustrated with thousands of well-done photographs of everything from lava flows to coon bones, they feel they are authorities themselves—or at least well informed. Yet they have no ability to observe, and no sensitivity to understand. Evolution to them is something interesting that stopped with the ape man. It bears no relation to their responsibility on earth, or the workings of their societies.

What then do we do? Should we take some high school students off the shelf and train them at government expense for a career in conservation? Should we make a conservation course a requirement of every curriculum? Should we offer extension courses to teachers or write more books on conservation experiences for children, or leadership guides, or put on more T.V. programs? Maybe we should put more emphasis on conservation projects in youth programs. Some of these approaches have been tried and found wanting. Others have shown some merit, but most of them, like legume seed sown without innoculum, may not produce the results we want.

There is no way on earth that an academic or an entertainment approach can ever strike enough sparks to keep a conservation fire going through the difficult times that face us. We have to get down to the fundamental problem of keeping Antaeus, that is the child of earth, in touch with the earth. The chief effect of our modern expansionism and materialism is to wall the child up in the city, suburb, or T.V. room, to protect him from experience by transporting him by car and bus, to make his haunts inaccessible by barriers of traffic, to contaminate his swimming hole with waste, and to divert him with activities and the necessity for conforming. Our chief objective, therefore, should be to release the child into contact with nature as often, and as unconsciously as possible. Too often in the past while we have fostered our attention on fish and wildlife we have neglected the child and the youth. Conservationists are too conservative. It is time we thought in more radical terms—the trends of the times require it.

Putting the child in touch with the earth will do more than just gain appreciation for conservation objectives. Society as a whole will benefit. Frank Lloyd Wright said, not long before his death, "I think distinctly the teenager problem is a problem of over-gregarious life. Life not with the green acres, not life where the wind blows and where a man is free to indulge his instincts according to his better nature, but where everything in him is likely to be developed by all these pressures that are exerted upon youth in the name of Education; he doesn't know freedom. . . . I never went to school a spring term in my life. The farm was so much more fascinating and instructive."

Where can a child adventure on his own today, explore, move out cautiously into the world the way all living things are meant to grow and learn? How can he escape the stultifying inhibitions of parents and society? I have a few suggestions. I am not an authority on how to put these ideas into action. I will leave that to someone else more practical than I. But I like to dream.

Our first objective might be to counteract the everpresent campaign for more security, put less stress on length of life and more on quality, less on financial security for ourselves and more on the health of the human community. This is my most dreamy suggestion. It is a bit like telling the deer to get out of the cedar swamp in mid-winter. They would rather starve than face the cold. Still, perhaps we can cut down some aspen, leave some slash, and entice them out. If the parents won't come out, maybe the youth will. They are the ones who face desperation. We already have our childhood experiences under our belt (which, for all too many of us, means pretty well protected.) Look around and you will still find youth trying to adventure, and you will also find in them a good bit of contempt for the kind of trap which we have created for them. We can encourage this contempt in a healthful way, but we must be prepared to offer them something more than mere disillusionment. In conservation we have a philosophy of constructive action, of change and improvement. It is not hard to sell this philosophy to youth. A revival of the CCC has been discussed and rejected. How about a state CCC, aimed at making cities livable?

Dream 2. Give the children ways and means of getting out on their own, a privilege which the automobile, the super highway, the subdivision and the city have all but annihilated. To accomplish this challenges the imagination.

One of the most fertile opportunities, it seems to me, would be to restore the opportunity of bicycling which has been lost because of traffic. With all the money for highways, memorials, expositions, sewage disposal and unemployment, there has not been a single penny that I know of for bike lanes and crossings. Who pays the penalties for this short sightedness but the ever greedy adult who has demanded the convenience of highways and automobiles? He is the one who now must run his children across town to the scout meeting, the band practice, the swimming meet, the football game, the dance. Children must wait for their parents to get into the mood for a picnic or a hike in the woods before they get a chance to get the scent of freedom that the open road has to offer.

"The Open Road" was once the name of a boys' magazine. Now it is an anachronism. There is no open road for boys, until they get on the highway behind the wheel of a car. Then they strive to release some of the pent up childishness which they could not express as a boy on a bike, coasting freehand down some hill, going some place new. I blame them not the least. They are the product of the world we have created for them.

Hiking trails, hostel facilities, and hiking clubs and programs are other opportunities for getting children in touch with something besides smog and asphalt. There are a few isolated efforts at this and there should be more. There are plenty of jobs waiting for a new CCC.

Dream 3: It has been common practice to make surveys of recreational use and demand, and to predicate subsequent park and recreational developments on these trends. I believe this is a one-way road to T.V. parlors at every state park, coffee shops at the end of every woods-road and penned-mallard shooting concessions at every roadside park. I am against these surveys as a basis for planning for two reasons. In the first place, youth is seldom represented in these polls. In the second place, to be conservation-conscious is not to just drift with the tide, but to have some convictions about a way of life. There are plenty of examples where courageous foresight, undimmed by mass desires, has enriched our lives. The state and national parks weren't started as the result of a poll. The Audubon Society, the Forest Service, the concept of the school camp, Boy Scouts and many other movements were brought to fruition not because a statistical study indicated people were doing these things or wanted these things, but because they were inherently good, and valuable in the maintenance of a way of life and an ideal. When we begin basing our total conservation program on surveys of use and demand, the American Dream will become a nightmare.

Dream 4: We should be frank to admit that under the conditions that exist today, conservation activities in the field of wildlife should not be supported solely, or even primarily, by those who fish and hunt. If we persist in adhering to the present formula we may regret it when land is all cut up by subdivisions and developments so that hunting is no longer feasible, and when streams are so motorboated and polluted that fishing fever fades. Evidently charging hunters and fishermen for licenses, and adding 10% to the cost of their equipment and ammunition has not deterred them from paying their money on the line. Conservation Commissions are shirking their duties, and running into unnecessary resistance as a result of continuing to accept the old formula of hunting and fishing support. As a lecturer for the National Audubon Society, I have been acutely aware of the numbers of people interested in birds—people from every field, not just crack-pots and professors, but engineers, architects and business men, respectable people.

Why shouldn't all of us, who are interested in conservation and the outdoors, support it? After all, in Michigan we manage the prairie chicken, but we do not shoot it, and again in Michigan, we have set aside a tract of land to be managed for a dickie-bird, the Kirtland warbler. We publish lists of flowers protected by law, and we set aside tracts of interesting flora, and provide, in public shooting areas and refuges, a home for much wildlife of no economic interest whatever. Many persons belong to national organizations by virtue of a contribution of five or ten dollars a year. They save redwoods, egrets, fur animals, national parks and relict floras, and these are all worthy causes. Nevertheless, all too often they are powerless to contribute to the conservation cause in their own state and neighborhood. It is high time picnickers, campers, and outdoors people, other than hunters, had an opportunity to express their desires and contribute their money toward the cause of keeping children and families in contact with nature. How about an excise tax on barbecue equipment, picnic jugs and charcoal?

Dream 5: It is said of Hamlet's mother, the Queen, that she could live with evil, until she was made aware of it. So with many of us. After years of urban enthusiasm an awareness of the city's failure to provide a home is fast coming over us. Mr. J. B. Jackson, editor of *Landscape Magazine,* in an excellent article called "The Imitation of Nature," said, "We . . . recognize that a significant aspect of juvenile delinquency is youth's rebellion against a hostile, unnatural physical environment, against ugly sounds, and smells and colors; houses and streets and cities designed for efficiency but not for highly sensitive biological organisms."

Who is concerned about the general quality of the environment which results when cities merge, metropolitan districts infiltrate the suburbs, the counties, the farms? Sooner or later, some zoning committee or planning commission picks up the responsibility, but not until economic interests override all other considerations.

Until now, state conservation agencies have remained aloof from the problems of the cities. Conservation ideas are rooted deeply in the rural scene. Yet, today ranting at, cajoling, and assisting the farmer are not going to solve the major problems facing us. It is the city man and the municipal administrator who have to learn about conservation, about the relation of living things to their environment.

State agencies, including conservation interests, must find ways to enter aggressively into land use planning in coalescing metropolitan districts, with the goal of providing parks, playgrounds, bike paths and natural areas for the future, and above all for providing some beauty, challenge and freedom in the lives of children.

In short, it seems precious few agencies in our society are concerned with keeping the child in touch with the earth. No one is concerned with creating or preserving conditions which will provide the future with Tom Sawyers and Huck Finns, and in turn with Mark Twains, John Muirs, Roosevelts, or Leopolds. We worry greatly about planning for the increased leisure time of adults. What about the vastly greater and more important leisure time of our children. Is a boy's Saturday of no concern to conservation agencies because he buys no license, pays no excise tax and shoots no game? Whatever the answer to this, there can be no doubt but that the way the boy spends his Saturday is going to have a telling effect on the future of conservation over the country.

DISCUSSION

MR. VESSEY: Our attention has been directed to a very important and, I think, a very vital subject. All of us are concerned with ways of preserving and providing the opportunity for outdoor recreation. Our national parks provide this kind of outdoor recreation and inspiration that almost anyone can enjoy. Without very much training and education, without supervision, these areas cannot be reasonably well taken care of. We are concerned about preserving enough wilderness. To me, wilderness is the cream of outdoor recreation. However, I wonder how many people in the United States really understand how to enjoy or how to use wilderness. You can all go on from there. Just make a round of public camp grounds and find out how few American families know how to use, let alone appreciate, outdoor recreation.

Surely, along with providing the facilities and the opportunities for outdoor recreation, must go a whole new movement of training the American family on not only how to use, but how to enjoy it.

I am sure that our education of the public is going to stem through the interest in children.

There must be some thinking going on in the audience out there.

MR. SELKE [Minnesota]: I do not want to monopolize this, but this field of conservation is something in which I am tremendously interested.

You refer to the parks system, recreation areas. In other words the enjoyment of the out-of-doors and so forth.

In Minnesota, where the state park system is under the Department of Conservation, I would like to refer to this whole program as a family integrating program, which is contrary to most of the things that we do at the present time; where we disintegrate the group, dad and mother, at a tender age.

If they have a park or recreational area near them, they toss the youngsters into the car and spend a few hours in the fresh air and sunshine. A little later, perhaps, the youngsters, when they get into their teens, they go out with their own age groups—camping with the Boy Scouts, Campfire Girls, and so forth. Then when they get a little older, with scheduled vacations that families now for the most part enjoy, they go out and in Minnesota, they see White Water State Park or Itasca State Park and so on and spend a week that way. However, almost always, the family should be kept together in this respect, especially in the early ages, when the contacts between dad and mother and the youngsters can be developed so that they may continue over a longer period of time.

I was very much interested in this very splendid paper. I think that in a very splendid way, it brought some of these things to our attention.

I also feel, that sometimes when these parents go out with the youngsters, they exploit and spoil the areas for the next group and that they should know not only as to how to preserve them for themselves and the next time they come, but for others who also come along. I think that is very important.

I have seen how these folk react, especially when they go out over the Memorial Day week end and the Fourth of July and Labor Day—with there not being adequate camp facilities anywhere to handle the crowds. Then of course, you have folks crowded in upon someone else and the question then as to what they do is important. Sometimes I have seen the recreational areas as crowded as city playgrounds and with no more of a program available for youngsters than I find in the dirty alleys of cities or the dark streets of cities.

MR. KIMBALL [Minnesota]: I also think that this is an extremely good paper. I don't think there is anything too much that we can add to it.

However, I would like to say, as Game and Fish Director in the state, I constantly am thinking of ways that we can help people to observe wildlife, the out-of-doors and so forth, and yet it is a real problem. You know we are constantly reminded that the men and women who purchase hunting and fishing licenses are paying our salaries, as well as those of everyone working for us and therefore we wonder how far we can go.

You know I am a bird watcher. I do not admit it at home but then I do like to get out in connection with this type of thing and do more of that than actual hunting and fishing.

How far can we go in spending money that comes to us, not only from the general fund, but also the money coming from those who purchase hunting and fishing licenses, but also from those who pay excise taxes?

How far will the hunters and fishermen let us go in providing these things in which most all of us would like to do a great deal more?

MR. ETTER: I am not very good at the practical ways of putting these things into effect, but I am glad to have your expression of this feeling and I think this is a problem that really does face us.

CHAIRMAN TUBBS: With regard to the last statement that was made, I would like to comment that I believe, through youth education particularly, that we might get a sense of at least consciousness that those who love to hunt and fish will find the things they love to seek in combination with these other things and the community—the ecological community. I do believe that as we get a better enlightened group of people assisting in making our laws and our programs and finances, that we are also going to get a deeper appreciation of the association of all of these things that go together and which make up the community, which means a good place for us to live.

WILDLIFE MANAGEMENT AND THE CUSTOMER

STANLEY A. CAIN
Michigan Conservation Commission, Lansing

In successful business ventures market study is as important as product research and development. Could this also be the case in various non-business fields? In wildlife management—in fact, in the entire field of public natural-resource management—it is my opinion that more attention devoted to the consumer would ease many a difficult situation and speed the application of science in practice.

We have quite properly studied the biology of wildlife species in its many aspects: life cycle, the physiology and ecology of the various stages of the life cycle, population structure and dynamics, the role of the species in its ecosystem, prey-predator relationships, pathology, and systematics. The same approach has been taken to sport and commercial fish, and appropriate science has been developed and applied to the management of forests, soil, and water. To some extent also scientific enquiry has been made into the complex interrelations among the many natural resources, especially as exemplified in habitat management, and important starts have been made in the integration of the several management specialties on national forests, some river basins and small watersheds, and in regional planning. Numerous engineering and other technological advances have been built on the basic natural sciences. There is a scattering of investigations of natural-resource administration agencies, of resource law and its enforcement, conservation education, etc. Economic studies have been made, especially as to unit costs, such as how much does it cost to produce a legal-sized trout? or what does the average hunter spend on his sport and recreation? The economic studies are about as close as many of us get to the consumer. Yet the solution of many of our management problems would seem in the end to depend on the habits, behavior, and views of the consuming public, our knowledge of consumer patterns and our ability, or lack of it, to educate people.

I would not carry the analogy with business so far as to say that "the customer is always right," for the professional wildlife and other manager, with the fruits of scientific research and controlled observation to call on, has a tremendous advantage over the sportsman, the legislator, and the general public in knowing what should be done. But the administrators of public natural-resource agencies are in a middle position between the general public and the lawmakers and their technical personnel (I guess to say that they often are "caught in the middle" would not be wrong) and they can't be concerned only with what *should* be done in wildlife management but must judge what *can* be done. Part of their problem is to judge the relationship between the possible and the probable. They must live with reality.

Such agencies at both State and Federal levels have a role to play beyond research, administration of public properties, and the enforcement of law. They have, as I have suggested, a central responsibility for education of the public. Administrative rules and laws are unworkable when a considerable portion of the public does not understand the need for them or does not agree with the objectives sought. If natural-resource management gets too far ahead of public understanding, agencies are in for trouble. The fruits of research in natural history may be lost and devoted public servants find themselves frustrated in their efforts to earn their salaries by serving the best interests of the public. Most wildlife and other natural-resource management problems start out as scientific problems, but they do not end up that way. Science alone has never solved a management problem that has wide interest for the public and impact on its habits and images. All such problems get tangled up in misunderstandings, partial understandings and conflicting opinions and, as a consequence, in political, legal, enforcement, economic, and other aspects of the management problem as a whole.

I will mention a few current or recent instances in Michigan to illustrate my point, and to show that the Department of Conservation can't please everybody—and sometimes it seems, anybody.

Our Commission several times has postponed a decision on a land exchange which has the full approval of the Department. The unsettled case is that of the Blue Lakes Club and a State inholding of forty acres completely surrounded by Club land and presently without access. This forty has become a minor *cause célèbre.* They lie on Black River, a fine trout stream which for several miles in the vicinity of the forty is largely controlled by private fishing and hunting properties. The Department's divisions of Lands, Fish, Wildlife, and Forestry all recommended acceptance of a land exchange proposed by the Club, their objective judgments being that the land exchange was advantageous to the public interest. The Club is acting on the same principle that often motivates the Department, the desirability of getting rid of inholdings.

Persons pressuring the Department to hold onto the land and not accept the exchange have put forward a variety of arguments. It is said that the land, which has a short frontage on the river, offers an opportunity for fishermen to leave the stream legally to rest or to camp. There are difficulties with such an apparently straightforward argument. The stream isn't canoeable, or at least only occasionally so, and the State land is too far from any other public access point to be reached by a wading fisherman. In any case the land adjacent to the river is low and damp and scarcely suitable for camping. Others argue for condemnation of a land access route, but the Department has long had a policy against condemnation under such circumstances, believing it would be poor public relations and of doubtful outcome as well as expensive. Some people just plain don't like private clubs and others have a pioneer feeling that the one-gallus hunter and fisherman really has a sort of God-given right to go anywhere in pursuit of that which, after all, the public owns. There are some commercial interests involved, too, and local sportsmen's organizations sometimes seem to get swayed to one side or another depending on the eloquence of the last person to address them. There is representation that the land was originally almost a gift because the former owners wished the public to benefit from the property, although the Department's purchase price was fully equal to the market price at the time. It is hinted that some Department personnel in the field lets its sympathies with one side or another of the question be known to interested parties irrespective of the judgment at Lansing. Finally, it doesn't help matters much in terms of fish and game management to learn that the Club has a large acreage and a very small membership and that one of the Club's officers is Arthur Summerfield, Jr., son of the Federal Postmaster General, a politically active Republican, and Michigan is a state with a sixth-term Democratic Governor who has been in office long enough to have appointed the entire present membership of the Conservation Commission.

What kind of information about people might help the Commission and the Department in cases such as this? The first point seems clear enough. If there is disaffection in the Department's ranks and possible conflict of interest, individuals should be identified and allowed full opportunity to present their views but should be required to close ranks once a Department position is firm. Public opinion as well as legal opinion should be sought concerning the matter of condemnation of access. It is not now known whether condemnation proceedings would in a case like this be good or bad public relations. The lands involved in the proposed exchange would give the public a longer frontage on the river, overland access, and lots of room for camping, but it would not increase the frequency of access points along the stream as would the forty-acre tract under discussion should overland access to it become possible. We do not know what the fishing public thinks about such an alternative in this case or as a matter of general principle. Is it true that when such a "rhubarb" develops you do not hear from your friends and those who agree with you but only from a vocal minority with special and perhaps vested interests? We have no means of identification and little means of evaluation of the sources and motivations of noisy objectors. We don't know what portion of the interested and affected public they represent. In more general terms than a specific case, the Department does not know how staunchly the public is back of its overall land policy. Should the Department sit tight and hold on to all public lands irrespective of the justice of an individual case because of the apparent future need for public recreational land?

Another confused or at least complicated current case concerns the Jordan Valley (this one in Michigan, not the Middle East) that has been selected by the U. S. Fish and Wildlife Service as the best known location for a hatchery of two million yearling trout capacity to be used to help restock lakes Superior, Michigan, and Huron as the lamprey is being brought under control. The proposed new hatchery is approved by the appropriate Canadian and American agencies and would supplement the capacity their several present hatcheries will have. Construction costs would be close to three-quarters of a million dollars and the annual payroll has considerable interest for local business as would the tourist attraction of the hatchery. The selected location is on State land and could be transferred to the Federal agency. This also seems to be a straightforward proposition, but there is more than meets the eye at first look. In the generally well-tamed landscape of the Lower Peninsula of Michigan the Jordan Valley is something of an unspoiled wilderness. There is some claim made that the State received at least part of the land, after it had been logged, subject to the State's protection of it from development—and nature protectionists aroused can throw around a lot of weight as we learned in Michigan over the Porcupine Mountains copper mining proposal in 1958. But there are other issues that are not as clear cut. Some believe that a case hasn't been made for the survival of planted trout in the Great Lakes, so that the whole venture is an ill-advised rush into uncharted waters. And in any case the new hatchery is needed only to speed up the operation as five million yearling fish will be available from other sources. Opinions in this case are colored by other circumstances. Some technical people as well as fishermen believe that hatchery programs have been and still are out of proportion to their value, especially in relation to the habitat improvement program. Still others believe that trout get too much of the State budget—more than they pay for—while warm-water fish get the short end of the worm, if I may adapt a phrase. Finally the State is confronted with a reduced income because of decreasing license sales and the new, contested system of distributing Federal money to the states. Retrenchment is never a happy procedure, and research, field administration, and the stream and lake improvement programs seem likely to suffer—more, so some people think, than the fish culture program. The State has never been able to get a Great Lakes fishing license, and its strong appeal to the Legislature at this session for a license increase has fallen on deaf ears.

Let me try out some questions. Do you think the lamprey will be controlled? Do you think that trout plantings will be successful in the Great Lakes? Do you think the chances of success in both regards are worth the investment? Do you think a wilderness tract under the circumstances of its rarity in the region is more important to the general public than another hatchery? Do you go along with the scientists? If so, with which ones? Do you consider yourself an expert? Are you mad at anybody? Have you transferred your gripe about something else to the question of the Jordan Valley hatchery?

Some of these questions can only be answered by research on fish, and whatever the results of research, they have to be effectively communicated to the public if the Department is to have good public relations. It is inevitable that related questions get associated in the public mind and that such a decision as that of the Jordan Valley hatchery is not to be disassociated from the deeper one of Fish Division policy as regards the relative weight given its several activities. Have fishing license sales been falling because of poor success, because of conflict between the different water-recreation activities, because of the growth of more attractive recreational activities, because of dissatisfaction with Department policy, or for other reasons? Who knows? Certainly the answers are to be found more in man biology than in fish biology.

We have a deer herd problem in Michigan, too. Just as there are more Indians in today's West of the TV than there were a century or so ago, so there are more deer in Michigan today than in pioneer days. Since the days of the lumber barons and the time when Michigan's white pine helped build Chicago and the prairie states and fires swept the cut-over lands and disillusioned farmers went on, I hope, to greener fields, Michigan's deer herd has generally flourished on aspen browse. It has flourished until in many areas the numbers have been so great that they have eaten themselves out of house and home. Starvation and disease and the depredations of the weak by roving bands of dogs and other predators account for many, many thousands of deaths each winter. The Department has made valiant efforts to educate the public to the management problem and for some years has operated an apparently successful any-deer season with growing public acceptance. In 1956, 47.4% of the deer hunters interviewed were in favor of an antlerless deer season. By 1958 the percentage was 60.3 and for 1959 it was 64.3. The returns so far from the postcard survey this year again show that nearly two-thirds of the hunters (about 95% tend to respond) believe that it is necessary to shoot does and fawns in some parts of Michigan according to a system of quotas and areas. Nevertheless, conservation leaders in the Legislature have called for a moratorium on killing mothers and babies, and House Bill 136 provides for repeal of the Conservation Commission's discretionary deer herd control authority. As Jim McKenna, one of Michigan's leading outdoor writers put it, "It all happened at a time when . . . the Conservation Department figured public acceptance of the deer program had pretty well been established."

Opponents of the Department claim a big jump in violations due to the existence of the system of permit hunting for antlerless deer, and the fact that the Department's law-enforcement staff is far under authorized strength because of three years of austerity. Poachers and meat hunters are on the rise. Some people don't place the same confidence in the opinion poll referred to above that the Department does and in any case claim, correctly, that there are many hunters who are strongly opposed to the lottery-type permit system. They also apparently don't believe in rule by the majority. Department policy for biological and economic reasons has never been pleasing to supporters of artificial winter feeding. Others claim that the herd has been seriously depleted in some areas. Finally, tourist and resort business has been hurt, so it is claimed, because tourists don't see as large numbers of deer as they would wish. They certainly don't see the winter kill, sometimes thirty deer to a section in heavily overpopulated areas. Perhaps for the tourist industry we should try out the western mule deer in Michigan for it can be seen in large enough bands to suit almost any quantity-minded nature lover. Marguerite Gahagan, editor and publisher of *The North Woods Call,* titled a recent editorial "Needed: Survey on People, Not Deer," claiming that "now the Division is too far ahead of the public." Sometimes Maggie is like bitter medicine that is good for you.

What should a state agency do in a situation like this? Should it roll with the punches? Should it yield to pressures? Should it stand on its ecological information that forms the foundation of its deer management program, risking temporary defeat by standing on principle with confidence in the public over the long haul? Should it militantly espouse its protection of the public interest? In this case scientific research has paid off in terms of the scientific basis for management of the deer herd. Is there a science, or art, of public relations, of communication, of opinion research that would match and balance the biological research on deer? Ethology is a growing part of biological science; what about the human behavioral sciences?

Hunters and fishermen tend to be like second lieutenants who become gentlemen by Act of Congress—they become experts by purchase of license. Actually, much of the differences of opinion that plague administrative agencies result from the experience of individuals who generalize their limited knowledge. This very human weakness can be challenged, perhaps effectively, if suitable techniques are used.

I will discuss briefly one more case to illustrate the point. Michigan has a sizable amount of public land. At the Federal level besides that under military jurisdiction there are wildlife refuges, forests and Isle Royale National Park. In State ownership the Department of Conservation administers forests, parks, game areas, recreation areas, and public fishing sites, and the Department of Highways has many roadside rest and picnic areas. There are numerous town and county forests and parks, some school forests, and one intergovernmental agency, the Huron-Clinton Metropolitan Recreational Authority, has a chain of wildland areas in southeastern Michigan.

Much of the public land came to the State by way of tax reversion. Some of it has been received as gifts, but many tracts in recent years have been purchased as funds were available and opportunity arose to get desirable land. Although these lands exceed seven million acres, there is much that isn't known about the public land situation. Even though the total acreage may be large enough to meet overall demand, much of it may be in the wrong place, unsuitable for high-demand uses, under the wrong dedication, or inaccessible or undeveloped. In any case, it has become clear in recent years that many parks, swimming areas, picnic areas, camp grounds, boat-launching sites, hunting areas, fishing and canoeing waters, and scenic sites are overcrowded now. What the future may bring is not known with accuracy, but one thing is sure. The slower we are about adjusting the fit between public land supply and demand for its use, the more difficult it will become. Not only will unit costs grow rapidly as they have especially in post-war years, but suitable land and water frontage are rapidly undergoing private occupancy and development that would seem forever to preclude conversion to public use.

To a considerable extent the Michigan public land program has been opportunistic. This is neither unique nor censurable. Public agencies have had neither the information about demand nor funds to meet it. It does seem, however, that the situation might be improved. If information about public recreation were more adequate and if reasonably reliable forecasts could be made, it is possible that there would develop strong support for an expanded land program. I must admit that in Michigan in recent years there has been little to encourage belief that the Legislature is likely to move in this direction unless there is a truly aroused public opinion.

The public agencies know what they own. They know where the land lies and they know a lot about its physical characteristics. They know something about its potentialities for recreational use. Inventory and appraisal can be improved but there are two requirements for this to be significant.

The first requirement sounds easy but isn't necessarily so—that is the development of a series of recreational land-use categories. These categories would describe use capabilities and would incorporate in their definitions data concerning existing natural features, location, accessibility, development costs, and carrying capacity. Each category would be divided into quality grades and the standard that would be held to would be determined by extrinsic factors such as locality, variety, and demand. But with the best conceivable set of capability classes, inventory and appraisal could be only approximate without detailed knowledge of the public for whom the public lands exist.

This brings me, then, to the second requirement. The public must be studied as carefully as the natural features to which past research attention has been largely devoted. It is not enough to know the numbers of persons presently engaged in the various recreational activities. We need to know more about them. How far have they travelled in order to engage in a given activity? What is the age-class distribution of the persons involved? What are some of their pertinent socio-economic characteristics? What is the frequency of their repeated activity of the given type, and at what places? How have these characteristics changed with time? Such data are straightforward.

Another type of information is more difficult to get without bias or distortion. For example, what are the minimum facilities and maximum distances that make an experience satisfactory? What conditions would make for optimum pleasure in the activity? To what degree is the activity indulged in as a second choice—sort of better than nothing—because of the inadequacy of opportunity and facilities for a preferred activity? Why does a person do what he does anyway?

These points can be illustrated by picnicking. Presumably couples, family groups, or larger parties would prefer a location near a stream or lake with an opportunity for varied activity, but what percentage of picnickers taking up space in an area associated with swimming would be just as pleased or perhaps more pleased with less crowded grounds elsewhere—in the woods, on a hill, near a meadow? The intensity with which Michigan's thousands of roadside picnic tables are used, despite the absence of water and sanitary facilities and the constant flow of nearby traffic, suggests the simplicity of requirements of many persons and the relative ease and cheapness with which more abundant and more satisfactory opportunity could be presented to the public. Also, removal of such activity from proximity to beaches and rare scenic sites suggests the possible doubling of the capacity of them without detracting from the former activity.

Man is more complex than deer or fish. It is more difficult to make the human behavioral sciences scientific and the results predictable than it is to examine the ethology of non-humans, but a strong effort in that direction should help wildlife managers and others to diagnose their problems and approach their solutions.

DISCUSSION

MR. VESSEY: Last week I was entertained at the home of the Forestry Attache of the German Embassy in Washington. Among the guests were several of his co-workers and one of them was obviously a very experienced hunter in Germany. I spent practically the whole evening with him and it was very interesting. However, all I could think of was what a way to hunt.

The reason I mentioned this is the fact that the very title of this refers to our folks in this country as customers. In Germany, obviously, you are a guest and, therefore, you must behave as a guest.

I am sure that we are a long way from the situation which would make hunting in this country the same as it is in Germany but, as our population increases and the acreage per person decreases, we approach that situation.

What I am concerned with is the knowledge, the understanding, the skill of discipline that we customers are going to exercise in relation to the wild animals we like to hunt.

PUBLIC RELATIONS AND EDUCATION IN THE WILDLIFE MANAGEMENT FIELD

ROBERT D. CALKINS
California Department of Fish and Game, Sacramento

The pressures and competition of civilization during the past few generations have brought into being two new arts.

One is that of wildlife management. The other is that of public relations.

They came into being for different reasons. But today wildlife management is looking to public relations for help in getting its job done better and faster.

Those who ply these two arts—wildlife managers and public relations men—have one thing in common. They both have been educated in the sciences and from them seek answers.

SCIENCES PROVIDE FOUNDATION

Wildlife managers rely on such sciences as botany, zoology, pathology and ichthyology while public relations men turn to psychology, sociology, economics and semantics.

Almost every sportsman and conservationist thinks of himself as an expert in the wildlife management field. Similarly most human beings believe in their hearts that they are expert public relations practitioners.

The fact remains, however, that education in the sciences and practice in the application of the laws and principles places the wildlife manager and public relations men in a category outside that of the self-anointed experts in both these fields.

Within the wildlife management field itself, full acceptance of this fact has yet to be accomplished.

At this point we must look to the educator who is the key, not only to providing better qualified people to serve wildlife management, but also to providing the foundation upon which full public understanding and acceptance of the philosophies and principles of wildlife management must be built.

BASIC CONCEPTS NEEDED

In the long run, citizens who have been educated in the basic concepts and needs of sound resource use and conservation are more amenable to supporting wildlife management than are those in ignorance.

Long range education programs which build solid foundations for understanding of resource use problems are essential to the future of the wildlife managers' programs. If today everyone had a solid conservation education background, chances are the problems of wildlife managers would be fewer than they are and their public relations better.

While we may dream about such a time in the future, we must work aggressively to create a nation filled with people who understand and insist on conservation philosophies being carried out for the public benefit.

REALITIES MUST BE FACED

The realities of today too often evaporate this dream of the future.

An old cliché in the business is that the wildlife manager could get his job done without too much trouble if there were no human animals in the natural habitat.

To better cope with humans, who are here to stay, the wildlife manager is turning more and more to people trained in dealing with human relations, public opinion and communication of information. These are the people who work at the art of public relations. Products of industrial competition, the wares of these people are being readily adapted to fill the needs of the wildlife administrator and manager in solving many problems.

The employment of public relations techniques and tools to expedite wildlife management is a relatively new field.

The essentials which make them work for industry also are effective in this area of wildlife management.

PUBLIC CONFIDENCE—THE KEY

Public confidence in an organization, program, policy or project is essential to good public relations. To create this confidence, industry usually aims its public relations efforts toward reflecting to the public an accurate, attractive picture of company policies, personnel management practices or of a product for sale. From the outset a planned course is set with public acceptance the goal. By repeating the image, keeping it accurate and up-to-date, identifying it with other things and ideas already having public acceptance, and by sticking to a straight course, public confidence is built, and good public relations are realized and the idea or product is sold.

The same principles work for wildlife management. Our policies are those of our agency, our products are management programs and projects.

SOUND POLICIES NEEDED

Good public relations can be built only on basically sound, forward looking programs, projects and policies. Public relations is not a "silver wand" which can be waved to convert poor programs and policies into good ones. Public relations people aren't magicians who can make a silk purse out of a sow's ear, although I'm sorry to say some have tried unsuccessfully.

Pitfalls on this path to good public relations which wildlife managers so often encounter, however, include unsound programs and policies set for expediency, or to evade a crisis.

Another malady is the palpitating program or policy, the image of which most often looks to the public like the circus fat lady reflected in The Hall of Distortion Mirrors.

Still another is lack of policy which leaves the wildlife manager operating in a vacuum.

One of the most important things public relations people often can do effectively is to dig out and demonstrate for the wildlife administrator that his programs or policies do not appear to be sound and the kind upon which public confidence can be built.

HONESTY IS ESSENTIAL

Complete frankness and honesty is essential in efforts to reflect the items in which an agency would build public confidence. Bad news, such as errors in judgment or operations, frankly discussed with the public, often can strengthen an organization's public relations. Hiding and trying to cover up, sooner or later leads to disaster both to the public relations on the outside as well as to the internal well-being of an organization.

To build public confidence in his work and his agency, the wildlife manager could well seek to develop a confident attitude in presenting not only the successful but also the unsuccessful aspects of his efforts. It is human nature to avoid unpleasant news, particularly if one is a part of that news. But introversion on the part of wildlife managers must be replaced with aggressive presentation of all the facts, good and bad, if the public is to understand, accept and support the goals of wildlife management.

PROVEN PRINCIPLES

There are other proven principles which lead to good public relations and successful programs adaptable to the needs of the wildlife management field. Among these are action by top management to construct policies and programs in terms understandable to the general public. People won't accept things they don't understand. This does not mean, however, that only those policies and programs which are immediately understandable and acceptable should be adopted. Policies, programs or projects which might be unpopular and give rise to charges of "poor public relations" can be developed into acceptable ideas and "good public relations" if they are sound and given proper, planned public relations treatment.

WORK ACCORDING TO PLAN

Essential to such treatment is a comprehensive information program conducted according to plan to solve specific problems of understanding among various groups or publics. This program should give attention not only to specific individuals or groups primarily concerned and vociferous on the subject at hand, but also to less interested groups which make up the public at large. Too often wildlife managers concern themselves only with the understanding of, say, sportsmen, while other publics and the people at large who actually own the resource involved are ignored. Good, lasting public relations depends on public understanding—not only understanding and acceptance by a tiny percentage of the public.

Methods, timing and media must be judiciously selected to fit the problem at hand to accomplish a given goal of public relations or education. Arbitrarily to set down a formula as to how to go about getting good public relations and educated understanding of wildlife management and to follow that formula under every circumstance is a common fault. Few of us in the business like to admit that this happens, but it does. Too often we race around going through identical motions trying to put out public friction fires. Instead we should be working to prevent the fires from starting by planned use of the informational and educational tools available.

TOOLS BEING IMPROVED

The form and techniques of using these tools which influence the thoughts, opinions and actions of people are constantly being improved and are increasing in number. There is an effective use for every media of communication in the wildlife management public relations and education business. At this stage of the work, however, adolescence rather than maturity is often reflected in the tools we choose and how we employ them to do specific jobs.

The illustrated written word, made available to the public in newspapers, pamphlets, bulletins, magazines and books, remains the proven backbone upon which lasting public understanding of wildlife management must be built. Speeches, television, radio, moving pictures, visual displays and various attention-getting gimmicks all are useful for special purposes. These latter media, however, should not be accepted as informational or educational panaceas, nor should their use result in the sapping of effort, time and money directed toward the printed word.

TALENT IS AVAILABLE

Wildlife managers and administrators today have within their own organizations unused or misused talent to employ these tools to assist materially in improving public relations problems. This talent needs to be given the time and opportunity to perform. To be effective this talent must be made an integral part of the head man's team, in a place where advice can be given and heard on what, when and how the signals should be called.

Similarly, the education specialist in wildlife management could be much more effective if he could work as a team with the public relations specialist on the first team in wildlife management. Too often in wildlife conservation organizations we find these talents buried so deep on organization charts they're hard to find. And in such cases, chances are the public doesn't have much confidence in the organization.

Wildlife management, education and public relations people are teaming up to get a better job of wildlife management done in North America. They are demonstrating every day that this combination works. Given greater opportunity tomorrow, they'll do even better.

DISCUSSION

MR. VESSEY: It has often been said and generally conceded that the job of wildlife management is about 80 per cent in the field of education and public relations and 20 per cent in the sciences.

DR. HARRISON LEWIS [Canada]: I was pleased with the emphasis that the speaker placed on understanding. That is, no doubt, a key word. If we pursue a subject very far, we soon come to the consideration of capabilities.

I observe that a report produced in Virginia not very long ago stated that the public had been divided into two classes—those who were capable of understanding the principles of conservation and those who are not capable of understanding the principles of conservation.

I wonder if the speaker would care to give us an estimate of the ratio between these two segments of the public?

MR. CALKINS: I am not familiar with the paper or the person who made this statement that you could divide the human race into those two categories. I surely would disagree very materially with the position taken.

I have the feeling that people in authority in America, if they have at least average intelligence, given sufficient information and an opportunity to learn, are capable of understanding what we are talking about—if we give them an accurate picture.

MR. VESSEY: I believe that Raymond Clapper said that you should never underestimate the intelligence of an American and never overestimate their knowledge. Maybe that applies. Possibly you cannot make that division.

MR. KIMBALL [Minnesota]: I certainly agree that they can all learn it. In fact, I think that is pretty much the salvation.

The most effective or most successful challenge that I have had in public relations work has been in actually giving, you might call it, a 30-minute course in wildlife management—where you get right into discussing population of animals—such as population turnover, harvestable surplus, carrying capacity, limiting factors—and that this type of talk has been most effective in connection with youth groups and once they understand those things, of course, put in very simple terms, then they can understand why you don't like to have bounties and things of that nature.

It seems to me that giving the public a chance to understand some of these fundamentals, particularly in the field of population dynamics, is the only way we are going to get the public to understand what we are trying to do in the field of management.

MR. VESSEY: One more thought I have myself is that a lot of us working in the field do a lot of talking—we do a lot of talking but are we training? In other words, are the people reading us?

Is there anyone else who would like to express an opinion?

MR. SHOEMAKER [Minnesota]: I would like to point out two points made by the last speaker which I think are very important.

In all of our state organizations, especially those who have recognized the need for a public relations office, they have oftentimes felt, as have persons trained in public relations, that this individual was so hidden in the staff that he was not effective in the planning of the activities of that department.

MR. CALKINS: I have only one word that I would like to say to the remarks made by that gentleman—Amen.

MR. DAN SALTZ [Missouri]: I would like to say that I am very happy to underline the many publics that we face—which the speaker has also done. However, it seems to me that he has raised a point that frightens me a little.

All wildlife belongs to the public and yet only the people who pay for this wildlife are the hunters and fishermen. Therefore, are we not urged to go to these people and tell them that they are not only purchasing it, but merely making use of it? Shouldn't we tell them that the public owns it?

MR. CALKINS: I don't know about your state, Dan, but we in California tell them, and we make no bones about it—that people should have an accurate perspective on what the problem is and who is footing the bill.

MR. SALTZ: I don't know whether you got my question or not and therefore let me phrase it another way. I am not trying to make a debate out of this.

In Missouri, for example, perhaps one-tenth of our public purchase hunting and fishing licenses. Are we to tell those people who do that, that the League of Women Voters has equal rights on how we shall manage the streams?

MR. CALKINS: Well, I would say that your Legislature is your deciding factor there.

What we do in connection with a group such as the League of Women Voters is that we approach them from their particular interest in the resource management field. For instance, we just went through quite an extensive program for improving our pollution control legislation there and in this case, the League of Women Voters worked closely with us and they were extremely effective in supporting our point of view. This is the approach that we take to this type of segregation of groups that you might call it. Everyone of them has an interest and therefore, you have to talk to them in terms they understand and in terms in which they are interested.

MR. SALTZ: Of course, I am not attempting to minimize the League of Women Voters but in Missouri we have control of this thing without reference to the Legislature, which it seems to me, complicates our problem somewhat.

MR. CALKINS: Well, I am not familiar with your specific problem, Dan.

All I am trying to say is that in the solution of these problems you have to look at the specific problem and try and work out a solution in terms of the specific problem and the people involved in it.

MR. CAIN: This isn't a question. I want to merely underline, by an anecdote, a point that Mr. Calkins made. He said, if I recollect, that if an agency makes a mistake, they should frankly admit it if they want good public relations.

NATURAL RESOURCES AND AMERICAN CITIZENSHIP: A CRITIQUE OF THE 25th NORTH AMERICAN WILDIFE AND NATURAL RESOURCES CONFERENCE

W. WINSTON MAIR
Chief, Canadian Wildlife Service, Ottawa, Canada

This 25th Conference, now drawing to a close, marks another milestone in a long and distinguished history of dedication to the cause of conservation. I refer to the fact that the Conference has this year been titled the North American Wildlife and Natural Resources Conference. There has never been any doubt in my mind, nor I expect in the minds of most wildlife people, that we have been concerned, at earlier conferences, with all our renewable natural resources—indeed wildlife cannot be divorced from such consideration unless it be placed in a zoological garden. There may well be virtue, however, in making it clear to the general public that we are not talking about wildlife versus other resources, but rather of conservation as a way of life, wherein wildlife receives equal consideration with other resource values on a full partnership basis. Indeed, it may not come amiss to remind ourselves from time to time that such is our general viewpoint. In any event, may this Conference, under its new name, continue the illustrious service we have all come to know and respect.

Seth Gordon, in his excellent paper entitled "Where We Stand Today in Conservation," has reviewed for us the history of accomplishment of not 25 such conferences, but 46! This has been most timely for there is some doubt expressed these days as to the value of such large conferences. I read just recently a comment by an eminent scientist administrator wherein he stated that anyone who thinks big science conferences are still serving the original purposes intended is deluding himself. He said the young, eager scientists present their papers in the hope that the old stagers, whose scientific reputations are well established and respected, will provide them with constructive criticism. In other words, here is an opportunity for a meeting of the minds—the young eager with the wise experienced. Unfortunately, the old stagers are in the coffee shop, discussing common interests and bygone days with others of the same vintage. It was this latter particular point that started me thinking on a slightly different tack.

Is it fair to blame conferences per se if those that should know better spend more time in the coffee shop than in the conference room? (I might say parenthetically that I don't believe the old stagers have any monopoly on the coffee shop.) It may be somewhat the fault of the program committee; in this particular case I am one of them, and I will have a few comments to make respecting programming as I go along. But I suspect that we as individuals have tended to lose sight of the real objectives of our conference. Gordon has pointed up the impact of this Conference over the years. If it fails to make contact with our thinking today perhaps we should review our personal attitudes to attendance. Suffice it to say that no one has offered any alternative to the conference approach, and this one still offers us the finest opportunity of which I am presently aware to refresh ourselves through vigorous, worth-while mental contact and exchange.

The theme of the Conference has been Natural Resources and American Citizenship. Naturally, when settling to my task of preparing this critique, I turned to the dictionary, as the reference most available to the public, for the meaning of the word "citizenship." I was distressed to find that the most commonly available dictionaries (to me at least) content themselves with stating that citizenship is the state of being vested with the *rights* and *privileges* of a citizen (Websters). Encyclopedias were not too much more help, although Encyclopedia Canadiana does state that one requirement of citizenship in Canada is that the person ". . . has an adequate knowledge of the *responsibilities* and privileges of Canadian citizenship." It was of course the word "responsibility" for which I was searching. Any consideration of Natural Resources and American Citizenship is likely to prove fruitless unless it is clearly understood that only as responsibility is fully exercised can rights and privileges be extended, or even maintained, over the long haul.

It is perfectly clear that one cannot, in a critique such as this, discuss every paper. Nor do I claim any competence to so discuss the many and varied topics. Thus I shall attempt to emphasize certain "areas" of endeavor that I consider important for the future, drawing upon the papers to introduce and/or support my theses. If I mention one presentation and not another, no unhappy inferences are to be drawn. If I offer criticism it is not to be taken as a personal thing, but rather as directed to us as a group. One of our first speakers was presented as a person who calls a spade a spade. I too was brought up in that philosophy. There should be no happier an environment for direct talk than this wonderful state of Texas, so please bear with me.

Much on the minds of many conservationists has been the question of human population increase—the "population explosion." Lowery, in the opening general session, pulled no punches in pointing out what it could mean to us on this continent. Several other speakers also referred to the subject. There are, of course, wide divergences of opinion as between optimists or "cornucopians" and "pessimists" regarding what this means in terms of foodstuffs, standards of living, etc., over the world, over an undetermined period of time. But all seem to agree that, as *Time* states it, "Reproduction seems to be one field where private enterprise always triumphs." Fisher, in his excellent paper entitled "Conservation for More and More People," provided us, I think, with all we need to get on with the job. He pointed out that it is safe to assume that there will be more and more people, but not safe to *assume* that there will be adequate resources conservation, however that is determined and measured. Whatever moves we may make, whatever choice we opt for with increasing productivity, we must still, as individuals, be able to project ourselves into the future of our descendants, into our national and international society. But this kind of thinking and projection of self, ladies and gentlemen, requires the highest possible standard of citizenship.

The general sessions have covered natural resources in relation to the individual and the community, and finally in relation to national and international affairs under the title of "Measures of Resource Worth." These papers have served to drive home to us our essential unity of purpose, and the need for "honest co-operation among different groups in so far as their consciences would permit" if I may quote again from Gordon's paper. A highlight for me was Atkins' comment that if we do not find a common area of interest and action we may well lose the very values we all seek to maintain. I hope these conferences, and the general papers heard these last several days will have served to convince us that we need not all agree on details to reach common understanding on principles; that having reached the latter we then can and must work constantly through research and management to a sound basis of fullest cooperation in multiple-land-use.

Time does not permit dwelling on individual presentations. We have heard how conservation can and does pay off on farms, ranches, tree farms and watershed areas. Governor Meyner of New Jersey presented some excellent thoughts on conservation in relation to the life of the nation that we hope will receive endorsation by senior executives and legislators across the country. May I, however, add a few further thoughts to the coverage of the general sessions, and a word of caution.

Zimmerman stated, in introducing the first session, that conservation cannot be considered in the abstract. Several speakers have very properly reminded wildlife and fishery workers that we are all working to the ultimate good of humanity. There are certainly, and will be, points and issues wherein we must hold the line, in the belief that we stand for man's best long-term interests. In many other situations we must employ to the utmost our research and management to make fullest use of new or modified environments created by the North American way of life. In some respects we in the fish and wildlife field have, I think, been overlong in mourning the demise of the old rather than grappling with the new, and so have too frequently done too little too late.

The economic values of conservation have been excellently presented at this session, and earlier. But economics, as the sole criterion for proper multiple-land-use cannot fail to slight wildlife and aesthetic values, and lead to loss of that enrichment of life we as North American citizens have a right to expect.

Thus all of us here at this Conference, representing all resource users, must use with great sensitivity the multiple-land-use concept or we will certainly be hoist with our own petard.

It was Albert Schweitzer, I believe, who said that "The great fault of all ethics hitherto has been that they believed themselves to have to deal only with the relation of man to man." What we are talking about today is the land ethic of Leopold, the relation of man to his living environment. Taylor, in a technical session, has told us something ~~of the thinking~~ in that regard in Europe, and he reminded us again that "man cannot live by bread alone . . . the hunger of the spirit cries out of the depths." Can we on this continent dare to say that we are at a point in our progress where we can decide the fate of whole species and of precious natural areas on the basis of dollars alone? Do we admit we know so much that we can afford to throw away these products of aeons, and thereby throw away the checks by which to measure our own progress? Is our culture so advanced that we can create richer, better treasures to serve the needs of our people through the years to come? Buchheister's outstanding paper in the Depredations Control symposium gave a positive "no" to these questions. I have heard nothing at this Conference to suggest "yes."

As has been stated, we are faced with the inevitability of more and more people, with concomitant growth in industry and resource exploitation. To meet recreational needs we in the fish and wildlife field shall be maintaining optimum, or I fear more frequently maximum, fish and wildlife populations. To meet the growing problems facing us we shall need to run even to stand still.

It was gratifying, then, to see a whole session devoted to depredations control. It was directed to bird depredations but might well, had time permitted, have dealt with a much broader field. This is a problem of multiple-land-use which *we* must resolve or we shall have it resolved for us, in a manner not necessarily oriented to our best interests. Lindzey summed it up nicely when he said "Bird depredations control research is a challenging *responsibility* for wildlife conservationists." Johnson, speaking on public health aspects of wildlife disease, provided yet another cogent reason why research into this field should be intensified. He was necessarily restricted in the field he could review in so short a time, or he might well have posed problems touching almost every area of our activities, and humans from the tropics to the poles.

There is a tendency among humans to apply, as a matter of course, mass treatment to any sore spot that arises. In the case of wildlife depredations, as with several other areas of concern with wildlife, there is real danger that the treatment will prove more deadly than the disease. It is heartening to find research and caution the watchwords of the speakers on the depredations panel. Both Buchheister and Parker set forth a philosophy of thoughtful action we all hope will prevail. Incidentally, I note mention in a recent issue of *Science Newsletter* that an international group of scientists is to meet in Washington to discuss "biological control of insects of medical importance." I would like to see more of that in our field of interest, and perhaps a session on the subject in due course.

Research has been reported upon in several of the technical sessions. It would be impossible to pull it all together in the time available to me. I was struck by the statement by Jensen and Allen on avian botulism, that thirty years after isolation of *Clostridium botulinum* type C as the causal organism in "Western duck sickness" we still have not identified with certainty the media utilized by the organism for growth and toxin production. I have just commented upon public health hazards with wildlife under depredations and all I said regarding the latter could be repeated here. With more people, more domestic animals, more intensive land use and maintenance of maximum wildlife populations for recreational use there can be no doubt that disease and parasitism will emerge as major factors in the conservation complex.

There are encouraging stirrings in the field of wildlife disease research and co-ordination, and we hope that vital dollars will be forthcoming to nurture that growth. Looking to our responsibilities of citizenship, we must ask ourselves if we are content to continue spending only thousands on biological research essential to healthy existence on earth (which according to Lowery's calculations is likely to be home for some generations to come) while spending billions to hoist ourselves into space.

It would be unfair to make invidious comparison between the several fine research papers we have heard. I enjoyed Hungerford's paper on moisture requirements of Gambel's quail and Tomlinson and Wight's paper on mourning doves. They reported on well-conducted researches with defined objectives. The paper of DeWitt and associates on pesticides was most timely, and should give cause for real concern throughout our nations. We had a session on pesticides last year, but the topic is of such major importance we should not let research and public information lag in the slightest degree—indeed we must increase our effort substantially.

I claim no qualification to speak on coastal and marine resources. Adding to my ignorance on the subjects discussed has been the fact that summaries of but few of the papers on that session were received before the Conference. (I might say that situation was not entirely peculiar to the marine resource people.) However, I should like to comment generally and favorably on the papers as I was able to hear them. They seemed well prepared, significant and well presented. Laws has reminded us, in his paper on whales, of the world-wide nature of many of our problems. I am disappointed that we have not had a single research, or management, paper on freshwater fisheries. For shame—I know there is good research in progress, that would be of great interest to all of us here.

I am disturbed too at the apparent complete lack of research into the social and cultural aspects of the wildlife conservation field. We are spending significant sums of money on wildlife now and plan to spend much more in the future, particularly with respect to the allied field of recreation. But there has been at this Conference no mention of research into the mores of our people, their motivation and their real needs. I am no social scientist or psychologist, but knowing the power of the advertising media I incline to doubt that the general public "demand" of today, as determined by "ear to the ground" techniques, is an adequate evidence of deep-seated needs, and a suitable criterion for projection of our thinking to the future. Dr. Cain, in his presentation, reinforced my thinking in this regard.

Reviewing the research papers generally, I feel constrained to remark upon certain features relating to our research as a whole. Hardly a technical paper given at this Conference has failed to suggest the need for more research. I would support strongly the pleas for more money and more staff in certain areas. But I have the unhappy feeling that we may not be using our present research resources to the best advantage. As Dr. Peter Larkin of British Columbia said at a recent conference in Canada, we used to spend ten dollars to solve a million-dollar problem, now we spend a million dollars to solve a ten-dollar problem. It was Dr. Hans Selye, director of the Institute of Experimental Medicine and Surgery at the University of Montreal who stated, in a recent article on "What Makes Basic Research Basic," that ". . . the need is not so much to define basic research as to distinguish between greater and lesser basic-research projects." As he stated "This distinction is of immense importance, both to the investigator who requires a standard by which to choose his subject and to the public who pays for his work in the hope of profiting by it." I would suggest the same is true whether you are doing basic or applied research.

I can speak from personal experience, and I would guess many at this Conference would support my statement, that there is a curious lack of understanding respecting the true nature and value of research, and its applicability in terms of time and place. Thus we see not infrequently research findings applied illogically, but more frequently, and unfortunately, an unwillingness to accept the general applicability of research findings because the research was carried out in another country, another state or province, or even in another county. It is that philosophy, I fear, that spawns a plethora of experiments and researches that while good in themselves are essentially repetitious and are carried forward with no great conviction by the biologists themselves, because they know data already available are adequate to their needs. Thus not only are money and time wasted but good scientists are demoralized. I do not overlook the possibility, of course, that some of our biologists may be reluctant to break new ground.

I should like to suggest two things. The first relates to co-ordination and planning *for* (not of) research. I hear fine things about co-operation in wildlife disease research and investigation among the southeastern states, and also there in some programs on doves and other species. Could that type of co-ordination be applied more widely to our general wildlife research, perhaps on a regional basis? I am not suggesting that good research can only be done by teams—far from it. But good research frequently is done by teams. As with colonial nesters, the grouping of good researchers under proper atmosphere seems to trigger a reaction whereby the individuals produce more than if in isolation. Such an arrangement may also prove more practical in terms of shared costs and elimination of needless duplication. It is bound to remove some of the pressures for short term ad hoc investigations. Perhaps we need to take a long look at our research responsibilities, federally, state-wise and provincially, and at our universities, to see if we are making it possible to carry out best and freest research.

My second proposal is this—We must encourage more synthesis in research. We now analyse everything to death, and sometimes, on reading the results, I am inclined to say "so what"! That is unfair, of course, since analysis is basic to good research and contributes mightily to good management plans and techniques. But as Governor Meyner said on Tuesday, we need to exercise the greatest judgment in the selection of our research, we need ideas, we need break-throughs. This calls for a greater effort in synthesis; we cannot meet the challenge through analytical research alone.

I should like to see this proposal extended to some of our sessions here. We have heard two excellent papers on pheasants. I should like to see a synthesis of all that is known on pheasants, to see if some important blocks of knowledge might not fall into place. The same might be done for a number of the major species over a period of time. Of one thing I feel certain, if the public, our executives and our administrators could hear such, ably done, at a session here, they would be better able to judge the propriety of requests for more research within their respective jurisdictions. I feel that researchers by and large have established media for exchange within their own ranks of information, but have failed to make known to the public what they know. Incidentally, may I make a plea at this point for clarity and simplicity in technical presentations at this Conference, and sparing use of long tables and complicated graphs.

Of management, both on land and at sea, I have little to remark. Our knowledge here is good—indeed in many areas we know more than we can put into practice, though I would caution that is no reason to relax. We have heard a number of good papers, and I can only urge that we continue imaginative, flexible and positive in our management. Stoddard, in speaking on wild rice production, spoke for a positive approach to making our marginal lands produce, so providing competition to drainage interests. Grizzell reported on how we can carry out fish and wildlife management on small watersheds. Males, in a general session, pointed up that this sort of development is sound business. Hay brought to our attention again the very serious problem of public access. That problem will increase with every passing year.

Techniques have too often been worked on to the detriment of more fundamental research. But Strakey, speaking on methods of enumerating salmon in Alaska, has reminded us of the continuing need for techniques of inventory, without which there can hardly be intelligent management. Papers by Buechner and associates and Craighead et al. on the use of drugs in immobilizing big animals have shown that work on techniques can lead to real advances in both research and management. Craighead reported the commencement of a most exciting research on grizzly bears, made possible through those developments.

I cannot pass research and management without reference to the paper on oil pollution by Giles and Livingston which epitomized the ever-present danger in this general area. It would be hard to overestimate the importance, and indeed urgency, of both research and management with respect to pollutions of the seas, inland waters, soil and air. We shall fail in our responsbilities if we do not attack these problems with renewed vigor.

Finally, then, I come to the session on Public Relations and Education. I would hesitate to place undue priority on any one phase of our work, but I believe that all will agree the subject of this session warrants the emphasis of last mention and hence first place in memory. That session has brought to light so many good points I hesitate to comment. It is a pity it was not a general session, so that more of the scientists might have been present. In our public relations, says Gilbert, we should plan for every contact, great or small. We should then speak clearly and distinctly, with authority but without being overbearing. To those admonitions I say "amen." Calkins made a statement I have long waited to hear—he says complete frankness and honesty is essential to good public relations. Errors frankly discussed with the public often can strengthen an organization's public relations. It is a sign of the times, a good sign, that citizen's groups are well-enough read and informed that they are no longer to be put off with half truths or evasions.

Fersh reminded us that for intelligent decisions it is essential that the public generally have a thorough understanding of our resources, and all aspects of their potential and management. The measure of success we achieve in that respect, he stated, is a fundamental test of the validity of both our political and economic way of life—for decision making in this area embraces rights but also responsibilities —or might I say a true ethical concept of citizenship.

And how are we to achieve that public understanding. Etter has stated we must focus major attention on our children, and the preservation of conditions for childhood experiences that can hope to produce new "greats" in conservation thought and action. This latter must not be done by conservation planning based on recreational-use surveys.

Dr. Etter has said so many things I should like to have said. There is no real substitute, in the development of an ecological conscience, for contact with the soil and the wondrous world of nature during the formative years of childhood. We shall not, however, make his dreams come true unless we can teach, or inform, at every age level in our human society. It may be true that the academic approach, by itself, cannot strike enough sparks to keep a conservation fire going, but the school years still constitute one of the strongest forces in the molding of our future citizens. Fersh made this point well in his presentation. But by what means are we going to teach the teachers? I am most sensitive to that point, having been recently informed that at the Grade 5 level birds are different than animals, and that crabs are one-celled animals. Sort of a "don't confuse me with facts" approach. It is going to take inspired, and informed teaching to see that the total impact of the school years is such as to turn out our children with minds receptive to the "ecological conscience."

In closing, may I refer again to Atkins' paper given at the first general session. He said our actions or neglect in conservation may be a national disgrace but are not to be considered an occupational disease. Ladies and gentlemen, in reviewing this Conference in terms of needs for the future, I have suggested the need for researches leading to the breaking of new ground, to break-throughs, the need for resolving a number of serious resource family problems, biological and physical, that prevent best multiple-land-use, and for increased public information and conservation education. These will be of no avail if we consider them only as chores for the other man, the other resource, the other occupation. Conservation, embodying in the fullest degree the ecological conscience, is the challenge facing each one of us on this continent personally; how we respond to that challenge will be the test of our citizenship.

ACKNOWLEDGMENTS

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

Friends, it is believed that you agree that this 25th Conference has been about the most successful of all of these yearly meetings. After listening to that excellent critique and program summarization, I am sure that you know why we were pleased to have Mr. Mair accept that important assignment. His appraisal of the program of this three-day conference is an exemplification of the international character and scope of the discussions and deliberations. You did a splendid job, Bill, and I wish that there were words to adequately express our thanks.

In behalf of the Wildlife Management Institute, which sponsors these yearly conferences, I wish to thank not only W. Winston Mair, but all of the many organizations, agencies, and individuals that contributed to the success of these meetings. Sincere thanks to the members of The Wildlife Society, and to Dr. John L. Buckley in particular. The members of the General Program Committee, which includes the heads of most of the national organizations and large federal land-management agencies, already know how much we appreciate their help, and Dr. Buckley is singled out for special commendation because he handled the many preliminary details with such thoroughness and dispatch. The programs of the technical sessions reflect his efficiency.

Speaking for all of the conservationists throughout North America, thanks to the press. While I seldom get to see a newspaper during these conferences, the coverage in the Dallas papers, so I understand, has been quite good. It is hoped that the wire services and other periodicals did even 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 Convention and Visitors' Bureau of the Dallas Chamber of Commerce. There have been no complaints, and we are indebted to the Bureau for the efficient handling of the conference registration.

It seemed as though you enjoyed last night's banquet. This is a large ballroom, and it was filled to capacity. Judging by the way in which it was received, the musical and variety show produced by Jack Morton Productions was up to standard. It was my 15th show, and I must say that it becomes more difficult each year to be able to use that word "variety."

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 things. Instead, the task becomes more arduous—both the available topics and headline speakers seem to be exhausted.

To have reached the point of exhaustion must apply to those patient and enduring ladies that keep Dr. Gabrielson and me going throughout the year and during these large conferences. Permit me that real privilege once again, friends, to ask Mrs. Gabrielson and my good wife, Bess, to stand for the ovation they deserve.

In view of the snow-storm transportation tie-ups in all parts of the northern states, the registration was all that we could expect. There were 889 enrolled at my last check, and when it is known that we never can get more than about 85 per cent of the people to register, this means that we have over 1,000 people in attendance. We had 561 at the annual banquet last evening—a capacity crowd. Again I am constrained to say, neither the registration nor the attendance record is our measure of success of these yearly conferences. The things that count most are the over-all program, the participation in the floor discussions, the good that comes from the related meetings, and the personal contacts that are made. These count much more than the number of people. If these yearly meetings do little more than reflect the current trends in the important phases of the work, and merely produce appraisals like Mr. Mair's, the time, effort and money is well spent.

Now then, we have made definite arrangements for the next conference. I am pleased to say that we are returning to Washington, D. C. in 1961. The headquarters hotel will be the Statler-Hilton, and the dates will be March 6, 7, and 8. It is hoped that you will be there. Thanks, and a safe trip home. Happy landings!

REGISTERED ATTENDANCE AT THE CONFERENCE

ALABAMA

Dale H. Arner, George A. Averitt, Mrs. George Averitt, Maurice F. Baker, James R. Davis, Pete Farrar, W. L. Holland, Thomas H. Hooper, Charles D. Kelley, Claude D. Kelley, Earl F. Kennamer, Raymond D. Moody, Dan W. Speake, Ion S. Waker, William C. Younger.

ALASKA

A. W. Boddy, P. D. Hanson, Edward J. Hoffman, Mrs. J. M. Honeywell, J. M. Honeywell, John E. Schwartz, Robert F. Scott, Richard R. Straty.

ARIZONA

J. F. Carithers, Fred Faver, M. N. Forman, Steve Gallizioli, Lee Hover, C. Roger Hungerford, Calvin J. Lensink, Leslie Olver, Jerome J. Pratt, Richard W. Rigby, Harley Shaw, Lyle K. Sowls, Robert G. Voder, Joseph M. Welch, Wendell Swank, Robert G. Whistler.

ARKANSAS

William Allen, Mrs. William Allen, Harold E. Alexander, Powell Clifton, Charles F. Cole, Nelson Cox, Henri D. Crawley, Jack Dyer, Gary C. Gorge, D. N. Graves, Leroy Gray, Andrew Hulsey, Douglas James, F. W. McCormack, Bill M. Medley, William J. Smith, Randy Wilbourn, Mrs. H. R. Wilbourn, Francis J. Williams.

CALIFORNIA

Lowell Adams, G. A. Bartholomew, David Brower, Edward F. Bruce, Robert D. Calkins, Maynard W. Cummings, William Dasmann, George D. Difani, William P. Elser, Ben Glading, Robert V. Golden, Seth Gordon, Mrs. Everett Horn, Everett Horn, Harald N. Johnson, Howard R. Leach, A. Starker Leopold, Fred B. Lifton, W. M. Longhurst, W. Y. Murphey, K. W. Newerf, T. H. Richards, Paul M. Scheffer, W. T. Shannon, Walter P. Taylor, E. J. Woolfolk.

COLORADO

Maurice L. Albertson, A. E. Borell, Mrs. Arthur H. Carhart, Arthur H. Carhart, Sam Clifford, Douglas L. Gilbert, A. F. Greene, John T. Harris, Keith G. Hay, Ralph R. Hill, Mrs. Gilbert Hunter, Gilbert N. Hunter, George F. Jackson, Mrs. E. R. Kalmbach, E. R. Kalmbach, Thomas L. Kimball, Vincent H. Reid, Laurance E. Riordan, Mrs. Laurence Riordan, W. R. Seaman, Dr. Oakleigh Thorne, Cecil S. Williams, Lee E. Yeager.

CONNECTICUT

Philip Barske, John Dear, Rudy Frank, Michael J. Stula.

DISTRICT OF COLUMBIA

Carl J. Baird, John Batterton, William Baxter, John B. Bennett, Stewart Brandborg, Robert A. Bridges, J. A. Brownridge, Louis S. Clapper, Henry Clepper, Ed Cliff, George Crossette, Arve H. Dahl, Frank C. Daniel, Major Russ De Groat, John D. Findley, Joseph L. Fisher, Gordon Fredine, Ira N. Gabrielson, Mrs. Ira N. Gabrielson, Fred A. Glover, Edward H. Graham, C. R. Gutermuth, Mrs. C. R. Gutermuth, James R. Harlan, Jay L. Harmic, Patrick Healy, Scot Heter, Fred E. Hornaday, Michael Hudoba, Mrs. Michael Hudoba, Daniel H. Janzen, Robert M. Jenkins, Frank W. Lara, W. R. Larrimer, Ross Leffler, Mrs. Ross Leffler, James T. McBroom, James G. McClellan, Stanley Mate, William L. Mathews, Coleman G. Newman, John R. Olive, Lansing A. Parker, Joseph Penfold, Daniel A. Poole, Harry E. Radcliffe, Helen V. Radcliffe, Carl D. Shoemaker, Mrs. Carl D. Shoemaker, Anthony W. Smith, Art M. Sowder, Charles H. Stoddard, Richard H. Stroud, James B. Trefethen, Richard W. Westwood, Mrs. R. W. Westwood, Ed Woozley, Gordon Zimmerman, Cdr. C. F. Zirzos.

FLORIDA

A. D. Aldrich, Charles A. Davis, Earle Frye, C. M. Kaufman, Don Strods, Ed Timmons, Dr. H. R. Wilber.

GEORGIA

Howard A. Miller, George C. Moore, Carroll J. Perkins, Harold S. Peters, Leon R. Thomas, J. K. Vessey.

IDAHO

Frank Cullen, Paul D. Dalke, Ray J. Holmes, Kenneth E. Hungerford, George W. Kyle, Ross Leonard, Harvey I. McNell, John Milodragovich, Robert L. Selter, G. Heber Smith, Glenn Stanger.

ILLINOIS

William L. Anderson, Oliver Bell, William H. Casey, David A. Casteel, John A. Crim, Joe B. Davidson, Ralph W. W. Dimmick, Mrs. Edwin H. Eichler, Robert M. Eichler, Tom Evans, Frank Gregg, George B. Happ, William E. Hewitt, W. D. Klimstra, E. L. Kozicky, Rex Lord, Max McGraw, John Madson, H. B. Mills, Kent N. Olson, Sam A. Parr, Ernest E. Provost, Thomas G. Scott, Ed Spanke, Walter O. Stieglitz, Douglas R. Stutz.

INDIANA

Durward L. Allen, William B. Barnes, James S. Lindsay.

IOWA

Kenneth D. Carlander, Mrs. John W. Crabb, Sherry R. Fisher, Arnold O. Haugen, A. N. Humiston, G. H. Meyer, Glen G. Powers, Mrs. Glen G. Powers, E. T. Rose, Alice Thoreson, Arthur S. Thoreson, Mrs. A. A. Thoreson, Ries Tuttle, Glen W. Yates.

KANSAS

Ray T. Amer, Virginia Amer, Frank B. Gross. Gordon R. Cunningham, Charles W. Dane, Lt. Theo. E. Drane, James B. Elder, R. W. Fowler, Mrs. R. W. Fowler, George C. Halezon, Mrs. George C. Halezon, David Heimbach, Ronald O. Hein, Lanny D. Jones, David D. Leahy, Charles A. McCabe, Marvin L. Plenert, Earl Stevens, Verl G. Stevens, Charles G. Stillwell, Loren Swenson, Dale Taylor, Larry S. Underwood, Donald W. Welch.

KENTUCKY

Edward Adams, Minor Clark, Mrs. Minor E. Clark, James E. Craddock, James Durell, Fred Hardy Edgar Hartowicz, Louis Krumholz, Michael F. Kaplan, W. L. Minkley, Arnold L. Mitchell, Edward Penrod, Frank Phipps, Dan M. Russell, Shirley Troublefield.

LOUISIANA

Robert M. Blair, Charley Bosch, Louis E. Brunett, Robert H. Chabreck, Jack O. Collins, Dan Dennett, Jr., Vinson L. Duvall, Ted B. Ford, Leslie L. Glasgow, Grits Grsham, Lewell K. Halls, Frank Heyward, Joe L. Herring, J. B. Kidd, Robert E. Murry, John O. Newsom, Harry Schafer, Kenneth C. Smith, Robert D. Smith, Herbert Stern, Jr., Mrs. Herbert Stern, Carl H. Thomas, R. K. Yancey.

MAINE

Roland H. Cobb, Howard Mendall, George Nucknam.

MARYLAND

C. E. Addy, Edwart T. Aud, John L. Buckley, Harry W. Camp, Walter F. Crissey, Clint Davis, James B. DeWitt, E. H. Dustman, Charles H. Heltzel, Robert R. Harris, Carlton M. Herman, Robert Holdenried, W. H. Kiel, Daniel L. Leedy, Joe Linduska, Leonard M. Llewellyn, E. Budd Marter, Martha Marter, Vincent Schultz, William M. White, Conrad Wirth, Stanley P. Young.

MASSACHUSETTS

Robert P. Boone, Richard Borden, Lee F. Brackett, Lester Giles, Jr., Charles L. McLaughlin, William G. Sheldon, R. E. Trippensee.

MICHIGAN

Rollin H. Baker, Stanley A. Cain, Warren W. Chase, Arch B. Cowan, Dean D. Doell, Alfred G. Etter, Charles E. Friley, Jr., James D. Greiner, H. P. Hackett, Fay H. Hartman, Paul A. Herbert, Mrs. Paul A. Herbert, George S. Hunt, Karl F. Lagler, Justin W. Leonard, Mrs. Jim McKenna, Jim McKenna, Vol Miller, James W. Moffett, Robert Personius, George A. Petrides. Jim Rouman, L. G. Schemenauer, Henry L. Short, Allan T. Studholme, D. F. Switzenberg, Peter Tack, Farley F. Tubbs, Casey E. Westell, Jr., S. C. Whitlock.

MINNESOTA

L. D. Frenzel, Jr., Arthur S. Hawkins, Jim Kimball, George W. McCullough, Kenneth L. Sather, Robert E. Schumacher, George A. Selke, John R. Tester.

MISSISSIPPI

Rod Berry, Henry Bobbs, Jr., Shirley Haskell, W. A. Haskell, Herbert E. Hosey, Rex Raney, Pat Ryan.

MISSOURI

T. S. Baskett, Mrs. Ewart H. Burch, Robert S. Campbell, Helen Cooper, F. Olin Capps, Osal B. Capps, Nita Capps, Bill T. Crawford, Vernon Bennett, Mrs. Vernon Bennett, Frank P. Briggs, R. A. Brown, G. Edward Budde, Ewart H. Burch, Ben Cash, Mrs. Ben Cash, Gene Dooley, Wm. H. Elder, Larry R. Gale, Ray Heady, Mrs. Ray Heady, A. J. Jackson, Jr., Dunbar Robb, Dan Saults, Jon Stanley, Edw Stegner, William E. Towell, Reed Twichell, Howard Wight.

MONTANA

John J. Burke, John J. Craighead, Merle Gee, W. J. Everin, Fletcher E. Newby, W. Leslie Pengelly, Eldon H. Smith, R. D. Taber.

NEBRASKA

Phillip Agee, William J. Bailey, Jr., Eugene H. Baker, Willard R. Barbee, Charles V. Bohart, H. O. Compton, Harold K. Edwards, Don Green, Raymond Linder, David L. Lyon, Karl Menzel, Clarence Newton, O. E. Orr, Robert Schick, Richard J. Spedy, Del Whiteley.

NEVADA

Daniel S. Evans, Frank W. Groves.

NEW HAMPSHIRE

Hilbert R. Siegler, Rachael L. Terrill.

NEW JERSEY

Lawrence Bohm, Harry Frome, Henry J. Kelly, L. G. MacNamara, Robert B. Meyner, Ted S. Pettit, A. H. Underhill.

NEW MEXICO

George E. Barclay, Elliott S. Barker, Mrs. Elliott Barker, Robert E. Latimore, Carey H. Bennett, Rose C. Bennett, Raymond J. Buller, M. F. Embrey, John G. Gatlin, John M. Hall, Mrs. Jean Hall, Bruce K. Harris, Bill Humphries, Samuel H. Lamb, Mrs. Robert E. Latimore, J. Stokley Ligon, Duncan MacDonald, Tom Moody, J. L. Sypulski, Elmo Trayler, Walter J. Wenzel, Merle G. Wischnofske.

NEW YORK

Phil Allan, John Bain, Stephen D. Browns, Carl W. Buchheister, John Bulger, Chas. H. Callison, E. L. Cheatum, F. Darling, Olan W. Dillon, Larry Durkin, Dr. George L. Fersh, Hamilton Hicks, W. Mason Lawrence, E. Laurence Palmer, Bayard W. Read, James B. Ross, Ross Spreckling, Gustav A. Swanson, William L. Webb, Richard F. Webster.

NORTH CAROLINA

Frank B. Barick, Robert A. Campbell, Hugh M. Fields, Roland McClamroch, Mrs. Roland McClamroch, Major J. L. Murphy, Clyde P. Patton, Thomas H. Ripley, Eugene E. Schwall, Charles H. Walburg.

NORTH DAKOTA

H. R. Morgan.

OHIO

John M. Anderson, Larry Cook, Charles A. Dambach, Mrs. Charles Dambach, Herbert B. Eagon, Maurice L. Glitz, E. E. Good, George P. Groff, B. K. Jones, Hayden W. Olds, Tony J. Peterle, Vernon Stevens, Tom Stockdale, Clarence M. Tarzwell, Frank C. Vail, Kenneth G. Wehl, Dale E. Whitesell.

OKLAHOMA

Bill Altman, A. P. Atkins, Buell Atkins, Billie Ballew, F. M. Baumgartner, Cloyee H. Bond, Clay Boyd, Buddy Bristow, Foreman Carlile, Bob Chaddock, Jewel Callaham, Earl W. Craven, H. A. Cupp, Verne E. Davison, Fred J. Dickson, Arlie Edge, Leonard E. Foote.

Nolen J. Fuqua, F. C. Gillett, Claude Goin, Bob Hemer, Julian A. Howard, Alfred Houser, R. D. Gray, Roy A. Grizzell, Gerald Iams, Earl Ingersoll, W. H. Irwin, Sam Jackson, Jr., Karl F. Jacobs, Leonard B. Jones, Tom Jessee, Fred Lawhorn, James Logan, Jr., Mary J. Maehen, L. L. Males, Bill McCain, Garvin McComas, Eugene W. Michael, William T. Nailon, Clem Pattille, Arnold Purvieance, Carl D. Riggs, Leland E. Roberts, O'Reilly Sandoz, A. M. Stebler, John L. Steels, Jr., Jerome F. Sykora, Atwood Thompson, E. E. Townsend, George H. Wallen, Dick Williamsen, George B. Wint, Mrs. George B. Wint.

OREGON

David F. Costello, Albert M. Day, Russell E. Getty, William B. Morse, P. W. Schneider, J. H. Van Winkle, Larry Worstell.

PENNSYLVANIA

Byron Beattie, Glenn L. Bowers, Harris G. Mreth, H. L. Buchanan, Charles S. Collins, David E. Davis, George J. Eicher, C. C. Freeburn, M. J. Golden, J. A. Hamilton, Gene V. Hansen, Mrs. Gene V. Hanson, Walt Henson, Albert S. Hazzard, Sam Houston, Mrs. Sam Houston, M. C. Merritt, Ralph W. Marquis, R. E. McDermott, Seth L. Myers, Harvey A. Roberts, Ward M. Sharp, Samuel P. Shaw, James F. G. Sheffer, John Sullivan, J. A. Thompson, Gordon L. Trembley, Fred Turrill, Robert S. Wingard.

RHODE ISLAND

George W. Banspach, Mrs. George W. Banspach.

SOUTH CAROLINA

Jim Webb.

SOUTH DAKOTA

Les Berner, Ernest J. Hughins, D. R. Progulske, John L. Seubert, Carl C. Trautman, Harry R. Woodward.

TENNESSEE

Gilbert Banner, Calvin J. Barstow, Lemuel Due, Forrest V. Durand, Tom Grelen, George E. Kelly, W. H. Kennedy, E. W. Means, Harold E. Warvel, A. H. Wiebe, Mrs. A. H. Wiebe.

TEXAS

Denny M. Anders, J. B. Anderson, Bobby G. Alexander, O. W. Aston, Charlie Ball, W. L. Baunn, Clarence E. Beezley, Carl Berglund, I. Bernstein, J. M. Bloxham, Mrs. J. M. Bloxham, Thomas A. Booker, Ed W. Bonn, M. H. Boone, Charles E. Boyd, Hinton Bridgewater, John F. Brooks, Dennis L. Brown, William H. Brown, G. A. Buder, Eli Richard Burdine, David J. Galley, Larry S. Campbell, John M. Carlisle, Robert L. Carlisle, Therone D. Carroll, Ted L. Clark, John Clift, Mrs. Charles Coffen, W. V. Connell, B. D. Cooper, Edwin H. Cooper, John W. Cooper, Mrs. Clarence Cottam, Clarence Cottam, John M. Cowan, Jr., Charles W. Dabney, Jr., Walton S. Daniel, Richard B. Davis, W. H. Davis, Everett T. Dawson, Richard De Arment, John G. Degani, Mrs. John Degani, Elgin C. Dietz, Ray Dinges, Howard Dodgen, Clyde Doran, John N. Dorchester, C. C. English, Frank Etheredge, Philip Evans, Charles E. Ezell, W. C. Glazener, Mrs. W. C. Glazener, Roger Godwin, Horace G. Gore, Charles E. Gray, Mrs. Lydia P. Gray, Houston Green, Loyda Guard, L. V. Guerra, Tommy Bailey, Robert N. Hambria, Samuel Henry, Paul Hickie, Vernon M. Hicks, A. D. Holmes, Mrs. A. D. Holmes, Clyde E. Holt, Ray H. Horton, Billy Hudgins, Jack M. Inglis, Charles R. Inman, Hal Irby, A. B. Jamkson, Albert W. Jackson, Jim Johnson, Vernon L. Johnson, Kenneth C. Jurgens, C. A. Keefer, Dorothy King, E. Van Klett, S. S. Knight, Ralph W. Krogerus, Mrs. Ralph W. Krogerus, Jack Lair, Leonard D. Lamb, Harold E. Laughlin, Hill Lawrence, Dan Lay, Henry J. LeBlanc, J. W. Lehmann, Val Lehmann, Allie Lewis, Leo D. Lewis, Fred G. Lowman, Jr., Harry B. Lyman, Jan C. Magee, Robert G. Magee, Rod Marburger, Mrs. L. C.Marlett, E. L. Marsh, Robert G. Mauremann, W. G. McClellan, Mrs. Frank McGilvrey, C. A. McMahan, Charles T. Menn, A. S. Milikien, Caroline Milton, Jeff W. Moore, Tom Moore, Ray C. Moore, John J. Morony, Janelle Musser, Ronald C. Naab, Bob Nichols, Joe D. Nichols, Roy D. Ogleby, Fred A. Palmer, W. C. Parker, Jack K. Parsons, Mrs. Pat Patterson, Ed Pewitt, Lonnie Peters, John R. Preston, Warren M. Pulich, Ramsey Charles, William Renfro, Roger W. Rich, Perry E. Robinson, Kenneth F. Rochart, Willis Royall, Jr., D. Gordon Rupe, Miss Elizabeth Scheaf, Tom Sherry, William C. Schmeer, Bob Sinclair, J. R. Singleton, Bernard E. Skud, Mrs. Dot Smith, Dwane Smith, Jay Snyder, R. L. Spicer, A. J. Springs, Ralph W. Steen, George K. Stephenson, Joe T. Stevens, Charles D. Stutzenbaker, Britt W. Swain, R. L. Tayloe, Jack Ward Thomas, W. K. Tiller, John E. Tilton, Marion Toole, P. B. Zzzell, Robert E. Van Cleave, E. R. Wagpmer, Norrell Wallace, O. G. Wallmo, B. G. Jack Wood, Gary Wood, Michael Wood, Charles K. Winkler, E. A. Walker, G. A. Wheatler, John W. White, Huey Whitehurst, James F. Wilcox, L. A. Wilke, E. R. Williams, William T. Wright, Ernest C. Young, Armand Yrzmategui, Howard P. Zweng.

UTAH

Jack Allshouse, Jack H. Berryman, Harold S. Crane, R. W. Crowe, Wayne I. Jensen, Odell Julander, Jess Lowe, Stanley B. Mulaik, Floyd C. Noel, D. I. Rasmussen, William L. Reavley, Emerson S. Smith.

VERMONT

George W. Davis, Egbert C. Hadley.

VIRGINIA

J. L. Chamberlain, Lawrence V. Compton, Dick Costley, D. M. Gaufin, George A. Gehrken, Thomas J. Hardgrove, Sam Jorgensen, Richard Lane, Howard A. Merrill, Ben O. Osborn, Thomas A. Schrader, E. A. Seaman, J. J. Shomon, Bruce P. Stollberg.

WASHINGTON

Kramer A. Adams, John A. Biggs, Helmut K. Buechner, Charles Granam, Allan C. Hartt, Norman P. Knott, Burton Lauchkhart, Al T. Prichard, Francys Prichard.

WISCONSIN

Robert S. Ellarson, Wade H. Hamor, J. J. Hickey, Lawrence Jahn, Robert A. McGabe, Herman F. Olson, G. E. Sprecher, H. A. Svensen, Ernest Swift, L. P. Voigt, Fred Wagner, Les Woerpel, Mrs. Lee Woerpel, Linda Woerpel.

WYOMING

Ralph F. Honers, Mrs. Ralph F. Honers, S. J. Jiacoletti, Dale A. Jones, Clyde Kranenber, Mrs. Clyde Kranenberg, Olaus J. Murie, Mrs. Olaus J. Murie, C. R. Noble, C. P. Plummer, George F. Wakestrow, Peter N. Tertipes, Fred R. Yeaman.

CANADA

R. S. Bradley, C. H. D. Clarke, Tom Harper, William G. Leitch, Harrison F. Lewis, O. D. Lewis, John A. Livingston, Miss Elizabeth Lloyd, Hoyes Lloyd, Mrs. Hoyes Lloyd, Alan G. Loughrey, Frank McKinney, W. Winston Mair, G. W. Malaher, David A. Munro, Bernard A. Nelson, Dr. W. F. Tisdale, Mrs. W. F. Tisdale, W. Blake Uren, Robert Webb, Bruce S. Wright.

ENGLAND

Dr. Richard M. Laws.

HAWAII

Joseph S. Medeiros, Wilbert Yee.

MEXICO

Dr. Enrique Beltran, Mrs. Enrique Beltran, Enrique Beltran, Jr., Lic Hector Beltran. Luis Macias, Lupe Macias.

NEWFOUNDLAND

Don Miller.

INDEX