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The Wildlife Management Institute wishes to express its appreciation to The Wildlife Society and to the many individuals, organizations, and agencies that contributed to the success of the Twenty-Fourth North American Wildlife Conference.

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GENERAL SESSIONS

Monday Morning—March 2

Chairman: KARL T. FREDERICK
Chairman, New York State Conservation Council, New York City

Vice-Chairman: EGBERT C. HADLEY
Chairman of the Board, Middlebury College, Middlebury, Vermont

BETTER LIVING FOR A GROWING AMERICA

FORMAL OPENING

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

It is always a pleasure to be able to participate in another North American Wildlife Conference. The familiar faces in this group indicate that there are many others who have the same interest in the subjects being considered here. One of the great values of such meetings is the opportunity to see and visit with old friends.

There are also many new faces—some who are attending this conference for the first time. Your presence in the group of informed conservationists is most welcome and visible evidence that that army is being constantly renewed and invigorated by new blood. These conferences are planned to stimulate better information on the management of all natural resources and thereby help maintain them.

Let no one have any illusions that all the conservation battles have been won. On the contrary it will always be necessary for an informed and alert public to see that the gains that have been made are not steadily gnawed away by those who would destroy anything for personal profit.

Conservationists have had cause to rejoice at the actions of the last Congress in passing several important conservation measures. Likewise important administrative actions have advanced natural resources conservation.

Those actions have been widely publicized, and I shall not take time to enumerate them.

However, there can be no cause for complacency. There are still many major problems whose solution will require united effort if good results are to be obtained.

One important item of unfinished business is the Wilderness Bill. This is needed fundamental legislation to establish a congressional policy and program that will preserve some of our land in its natural wildness. It affects only about 2½ per cent of our land and, as now drafted and introduced, avoids interference with other programs and existing interests. There is no sound public reason why the present bill, S.1123 and companion measures in the House, should not be enacted.

Nevertheless, we have a fight on our hands. We may as well recognize it. The fight is not against any interests who will be damaged by the proposed bill but rather it is against interests who have hopes of raiding the few remaining areas of wilderness for their own purposes *whenever the future may offer them a chance.*

The very fact that livestock, lumber and other commercial interests are so ruthlessly fighting this bill is evidence that they are actually opposed to reasonable safeguards for any public areas. Their pious words for wilderness are forgotten when they face a practical program to preserve it.

I know that some of the chief proponents of this Wilderness Bill have hoped to avoid controversy and have done everything possible to design a measure that meets valid objections. This is a good way to plan and develop a sound public program. But I have said from the beginning that we need not kid ourselves. The same interests that have been trying to raid public lands for their purposes are going to fight any program for more effective protection.

We should start here and now to see that all the people of the United States understand the issues at stake.

Another important problem is that posed by the phenomenal growth and the use of a bewildering array of exceedingly toxic pesticides. Many of these are now used massively by people who have little knowledge of their toxicity and no knowledge whatever of their cumulative effects on other living things, including man himself.

Conservationists should clearly realize that control of many insect and plant pests is necessary. But certainly there is a desperate need for additional safeguards against uncontrolled distribution and use and more knowledge of the effects of even carefully controlled use of these toxic chemicals.

We should support greatly increased appropriations for the needed studies to determine the effects of these chemicals, to develop safer methods of accomplishing pest control, where needed, without the present threat of injurious effects on animal and human life.

A third major battle is already underway to maintain the ground we have gained in the field of water pollution abatement and control.

The present budget proposal cuts the grants-in-aid program in half and proposes to eliminate it entirely in the following year. These grants-in-aid have stimulated the construction of more sewage treatment plants than any method yet devised—or tried. The program should not be decreased. It should be doubled.

A major effort will be needed to preserve and strengthen this excellent program. And the deplorable condition of many of the nation's waters demands that this be done.

Many other problems will certainly arise before this Congress adjourns. But these are already with us. They require and merit the support of all of us.

In conclusion may I remind those of you who are here for the first time that this is a conference, not a convention. The General Sessions have been developed by a committee drawn from many conservation organizations, and agencies. The Technical Sessions are the work of a committee from The Wildlife Society. They are designed to provide information and stimulate discussion.

Any actions taken on any subject discussed will properly be taken by the various conservation organizations themselves.

This conference traditionally passes no resolutions or takes any action and all session chairmen are requested not to entertain any motions.

It is my great privilege now to open the 24th North American Wildlife Conference.

TAKING STOCK IN CONSERVATION

ELMER F. BENNETT

Under Secretary, Department of the Interior, Washington, D. C.

I want you to know that it is both a pleasure and a privilege for me to address this 24th North American Wildlife Conference. Your theme—"Resources, People and Space"—is a tribute to the breadth and imagination of your officers who have planned this conference.

The theme of this morning's session is "Better Living for a Growing America." I could easily spend the time that has been allotted to me in discussing the vital role that natural resources have played in the prodigious growth of our economy and in the achievement of the world's highest standard of living. I could also review the brilliant history of conservation in America during this century, and I might even be tempted to give special emphasis to certain things that have happened since the beginning of 1953. After careful reflection, however, I decided against this approach, mainly because I felt that it would not be particularly illuminating to this well-informed audience.

I would instead like to devote much of what I have to say to the future rather than to the past. But lest I be accused of completely neglecting what has happened before March 2, 1959, I would like to describe briefly a few of the major legislative actions taken by the Federal Government in the field of conservation within the past few years. These measures came into being largely through the efforts and leadership of many of you and your predecessors and associates.

In the development of conservation and management programs for our public lands, the concept of multiple use has become increasingly important. A most significant piece of legislation in this field is the Multiple Surface Use Act which was passed in 1955. The main purpose of this Act is to promote the full and sound use of all the resources on many of our public lands. It gives the Federal Government the right to manage the surface resources of unpatented mining claims, including the sale of timber, the grazing of livestock, and the use of the surface for access to adjacent lands. Since the passage of this law, the Department of the Interior has established the authority to manage the surface of 3 million additional acres of land.

In 1956, the Fish and Wildlife Service was reorganized, and the new Office of Assistant Secretary for Fish and Wildlife was created. Thus, for the first time in our history fish and wildlife conservation was given "little cabinet" status.

The Fish and Wildlife Service has also been greatly strengthened by amendments to the Coordination Act of 1946 which the President signed into law last August. This legislation for the first time makes the improvement—not merely the protection—of fish and wildlife resources a specific purpose of Federal water resource projects entitled to equal priority with the other purposes of such developments. This, I know you will agree, marks a significant milestone in conservation legislation.

Another important step forward was the recent action of the Department of the Interior to establish a 9-million-acre Arctic Wildlife Range north of the Arctic Circle in Alaska. This huge addition to the national wildlife system brings the system's total acreage to an all-time high of nearly 27 million acres.

After close consultation with representatives of conservation groups, the Secretary of the Interior promulgated new regulations governing oil and gas leasing on Federal wildlife lands. These regulations prohibit leasing on wildlife refuges unless oil is being drained from beneath them by nearby drilling, and permit leasing on other wildlife lands only if it will do no significant harm to wildlife.

Last summer, the President signed another historic piece of legislation which may increase refuge lands by as much as 50 percent over the next decade. This law raised the price of the Federal duck stamp from $2 to $3 and earmarked all the net proceeds from the sale of these stamps for the acquisition of national wildlife refuge lands.

Finally, I would like to mention the Administration-supported legislation, assisted by many of your great leaders, that established the National Outdoor Recreation Resources Review Commission last summer. This public body will take a long look ahead at our future recreational needs and recommend ways of meeting them.

Despite these notable conservation accomplishments, much remains to be done. Indeed, the very existence of the organizations participating in this conference is a recognition of the fact that the Federal Government cannot and should not attempt to do the job alone. The task can only be accomplished by close and effective cooperation at all levels of government and among all interested groups and individuals, both private and public. Sound conservation practices have more than proven their worth in the past, and they will be even more important in the future, as our population continues to grow and our economy reaches unprecedented levels of production.

But will this be enough? I submit that our economic growth and leadership of the free world in its struggle against the forces of tyranny will require more than the sound management and wise use of our resources. A large part of the job will have to be done by science and technology which have already demonstrated the basic fallacy of the Malthusian doctrine that an increase in population cannot survive on a diminishing resource base. The remarkable achievements of science in the fields of agriculture, minerals and energy—to mention only a few—are almost commonplace.

For example, between 1870 and 1958 our farm output increased fivefold while our population trebled. Similar progress has been made in minerals and fuels. Research leading to a better understanding of existing deposits, as well as new and improved tools and techniques have been responsible for continued discovery and development.

In the 25 years between the two world wars, 30 different metals and minerals came into use or moved from casual into quantity commercial production. About 25 additional items have found a place in present technology or are being investigated and developed. Synthetics assume ever greater importance as substitutes.

I could go on to describe the technological advances that have occurred in the generation and transmission of electric power and in the conversion of saline and brackish water to fresh water, the reduction of evaporation losses, and the recharge of underground reservoirs.

There is little doubt that we will become more dependent on research and technology in the future than we have been in the past. The fact that the conservationists in the early part of this century did not give sufficient emphasis to the role of technology is quite understandable when we consider that our population in 1900 was only 75 million as compared with more than 175 million today. Since waste and neglect of our resources were then so conspicuous, the early conservationists found more than enough to do without being too concerned about the contributions of technology.

While science is now receiving increasing attention in government, business, and education, there is at least one other direction to which we must turn. At a time when plans are being made to send men into outer space, when eminent scientists are urging us to spend tens of millions of dollars to probe the depths of the oceans, our thinking and actions in the field of natural resources can no longer be cast merely in a national mold.

Many names have been used to describe the age in which we live. Some have called it the nuclear age, others call it the space age. All of these names have merit. But surely we are living in what is above all an age of interdependence. What happens in any part of the free world is of vital importance to all of us—be it a revolution in Cuba or a famine in India. As the leading ration of the free world we must recognize that in the final analysis the strength of the free world coalition may well be hinged on its weakest member. Stated in the abstract, I am sure this proposition sounds like a platitude, but I firmly believe that what we do in the field of natural resources may have an important bearing on the survival and growth of free institutions throughout the world.

It is only fitting that I should discuss here, then, some of the international aspects of natural resources development, since this city is the home of the United Nations, and the world's largest center of international trade and commerce.

While much remains to be done right here in America, it is my firm conviction that we must orient our thinking and extend our horizons beyond the needs and resources of the United States or even North America. The need for broadening our perspective on resource conservation and development arises both from the rapidly growing demands of the American economy and out of America's responsibilities as the leader of the free world. (What we do to develop our resources must aim not only to strengthen America, but also to strengthen our allies and friends throughout the world.)

Our international role introduces a new factor into any assessment of our needs and resources. We must consider the needs of the entire free world, and in appraising our own resources, we must give adequate recognition to the vast undeveloped resources in many parts of the world. The needs in America and other industrialized countries are growing rapidly enough, but they will be immensely augmented by the increasing requirements of the less-developed countries of Asia, Africa and Latin America. There is in these less-developed countries a deep and burning desire to provide a better life for their people who have endured so much poverty. It is this battle against poverty that may be most decisive in the global contest for men's minds and hearts.

Thus, our world responsibilities impose an additional demand on our own resources but at the same time they offer a golden opportunity in terms of vast untapped resources available for the good of mankind. Many of the countries of Asia, Africa and Latin America have tremendous stores of undeveloped resources. The United States and Western Europe have the capital and know-how. Surely this cries out for the enterprise, ingenuity and international cooperation for the mutual benefit of all. I do not mean to imply that there are no formidable obstacles in the way. But I am confident that private enterprise, both here and abroad, with constructive assistance from the governments of all the nations concerned, can overcome these obstacles.

During his administration, President Eisenhower has made a number of imaginative proposals to mobilize the world's resources to fight poverty and disease. In his celebrated "Atoms for Peace" speech before the United Nations in December 1953, the President recommended the formation of an international pool of atomic energy resources and technology. This proposal has culminated in the establishment of the International Atomic Energy Agency.

Only a few weeks ago the President urged that we and our allies join in dedicating our surplus food production to the cause of world peace. The President has directed the Secretary of Agriculture to explore with other surplus-producing nations all practical means of using food for peace.

Among the earliest attempts at international cooperation for the conservation and sound management of an important wildlife resource was the negotiation of an agreement for the protection of the fur seal population of the North Pacific Ocean. In 1911, the United States, Canada, Japan and Russia, concluded an agreement providing for the prohibition of the wasteful practice of pelagic sealing which, at that time, threatened to destroy the seal herds. As a direct result of this treaty, the fur seal herd which migrates each summer to the Pribilof Islands in the Bering Sea has increased at an unprecedented rate and is now managed on a sustained-yield basis.

In 1916, the United States and Canada, alarmed by the indiscriminate slaughter in both countries of migratory birds, signed an agreement for the protection of the threatened species. In 1936, a similar agreement was signed with Mexico. Conventions with the Governments of Canada and Mexico provide for the protection and management of most of the species of birds that migrate through our three countries.

International cooperation under these conventions includes not only the development and enforcement of hunting regulations but also a broad program of aerial and ground population surveys and research studies. As the principal user of the resources, the United States has assumed principal responsibility for coordinating the management programs. In addition to the signatories of the agreement, the Goverments of Cuba, Haiti, and the Dominican Republic permit foreign personnel to conduct aerial population surveys in these countries. The cooperation of all these countries in fact-finding programs has been invaluable in the management of this important resource.

While on the subject of international cooperation, I believe that the time has come when serious consideration should be given to the negotiation of an agreement among the United States, Canada, and Mexico, for some form of reciprocal treatment of hunting and fishing licenses issued to the residents of each country. Since there are no obstacles to the free exchange of our currencies, I see no reason why, at least in some measure, the same principle should not apply to hunting and fishing licenses.

The various international agreements, notably in the Pacific Coast halibut fishery and the sockeye salmon runs of the Fraser River in which the United States participated before 1945 were mainly of an experimental nature. Several devices and procedures for the implementation of conservation policies have been tested with varying degrees of success. The International Commission has proven to be an effective instrument for dealing with conservation problems, and has been widely used in recent years.

There was one feature that characterized virtually all the early fishery conservation agreements. In almost every instance, action was taken by the governments concerned only after serious depletion of the fishery resources already had occurred. These agreements were mainly curative rather than preventive. But the gradual recognition by governments of the vulnerability of certain types of fisheries to unwise regulation and excessive exploitation soon produced a change in approach.

Perhaps the first example of this change occurred in 1945 when the United States announced plans to establish conservation zones for the protection of fisheries in certain areas of the high seas contiguous to the United States. In areas where other countries had developed or would develop fisheries, zones could be established by international agreement.

This policy had long been advocated by conservationists, including a substantial section of the American fishing industry and has resulted in a series of important international agreements, most of which have taken the form of international commissions.

Only six months ago, the United States signed four international conventions that were developed at a conference convened by the General Assembly of the United Nations in Geneva in February 1958. Representatives of 86 nations attended the conference where the objective was to examine the report on the law of the sea prepared by the International Law Commission of the United Nations and to adopt a series of conventions embodying the recommendations of the Law Commission.

Of the four conventions, I believe that the one on "Fishing and

Conservation of the Living Resources of the High Seas'' is of particular interest to this audience.

It represents the first attempt to formulate a broad framework of law which seeks to insure the maximum freedom of fishing on the high seas compatible with the requirements of conservation and the recognized interests of coastal nations. The convention requires all nations which fish on the high seas to adopt conservation measures. It also establishes certain rights designed to protect the special interests of coastal nations in maintaining the productivity of the living resources in the high seas adjacent to their territorial seas. And finally, machinery has been created for the expeditious, objective, and peaceful settlement of disputes that may arise from the application of the convention.

At the risk of being guilty of gross oversimplification, I would like to close this talk with a very brief summary of my remarks on resource development—past and future.

The grim prophecy in the 19th Century of Thomas Malthus that our natural resources could not sustain a growing population did not give proper recognition to sound management and scientific ingenuity, at least in the United States and the Western World. Technology has become particularly important in recent decades and will undoubtedly continue to produce new miracles in the future, if necessary support and incentives are maintained for basic and applied research.

The newest force in the resources picture is to be found in the vast underdeveloped areas of the world. Our dependence on these countries for many of our most essential raw materials is already great and may well continue to grow in the years ahead. The sound development of their resources is clearly in our interest as well as theirs. But what is perhaps even more important and frequently overlooked is that the economic development of these countries will serve the cause of freedom everywhere.

To meet this supreme challenge will require not only the fullest use of all the weapons at our command—foreign investment both private and public, international trade, international sharing of technology and the like—but the development of new instruments and techniques, and a sympathetic understanding of the social and cultural barriers to economic development in many of the less developed countries. I earnestly believe that we will be equal to this monumental task and that the next few decades will and should usher in a golden age of plenty for all mankind.

RESOURCE POTENTIALS IN POLAR REGIONS

PAUL A. SIPLE

Scientific Advisor to the Chief of Army Research and Development, Washington, D. C.

I assume that one of the reasons why a polar explorer is asked to come to a Wildlife Conference to speak is in part due to the circumstances of this past year. We in the United States have continued to add to our interests in world affairs in a direction both north and south. This year, commemorating our first polar State of Alaska, brings our realization closer and closer to the North.

Our added interest, beyond the International Geophysical Year, is to continue indefinitely scientific exploration and exploitation of Antarctica. This has added and will continue to add interest in the far South.

Alaska, as you all know, was known as "Seward's Folly." Seward would have been pleased to have seen how well he has been vindicated by the fact that Alaska is now one of our States of the Union. The real folly came, perhaps, when the American public let slip from its hands its rightful part of a portion of north Greenland, which in treaty we literally gave away.

In the far South, due to a lack of public understanding, we could just as easily lose that heritage that we have gained in the past years of a portion of the world which has direct interest to America.

So I would like today to try to tie together some of the wildlife and conservation interests that may exist in these far regions of the polar area. Actually, it is no great stretch on our part to extend ourselves in our thinking to the Polar regions when we realize that some birds actually make the flight twice annually from Pole to Pole —at least, from the Arctic Circle to past the Antarctic Circle—the Arctic tern being most famous, perhaps, for this tremendous flight throughout the north and south latitudes of the world.

Actually, relative to the scope of this particular Conference, of "Resources, People and Space," it is obvious that these polar regions are devoid of any great amount of people, but they do have a great amount of space. Space is of considerable importance to the conservationist. I recall so well a few years after the war—and I am sure it has repeated itself time and time again—that the Army, as have other Services from time to time, wanted to find space to carry out experimentation. Space in the continental United States to the average American is a great chunk of territory out in the desert regions of the Southwest, which seemed to be a very available space. It wasn't available by any means. Only those who have an intimate knowledge of a region of that nature would appreciate the amount of interest that was given to that region by so many different governmental agencies and private groups: airlines' rights, railroads and highways with rights of way across the region; water rights and refuge rights for animals—one of the most difficult for many Army people to understand was the fact that a certain mountain peak that they wanted to use as a range was a refuge for a certain type of rare goat, and it was preserved for that reason. I don't deny the importance of conservation for that purpose, but it adds to the importance of the task of those of you who seek space and territory for the preservation of certain animals and plants in their natural habitat to find space for a growing world of people, thus the Polar regions perhaps express in themselves a future of space for man's activities.

We have often thought of space as a barrier, a barrier that in times of war kept away the enemy. The oceans at one time were fine barriers. They are so no longer. The Arctic was a barrier that even stopped men's minds because we used Mercator's projection, and as we looked up we saw just a great blank across which no one's mind extended. Now we are thoroughly aware, in this space age, that there is no barrier there that airplanes and missiles cannot cross. Our radio traffic crosses the region. As we examine it more closely, we discover both in history and in the future, that this mass of sea ice is not a very permanent thing. A few centuries ago traders from northern Europe were able to go out in small boats and cross through areas where ice-breakers now have to be used to get into the Arctic Ocean. The sea lanes now have been opened further by submarines that can negotiate under the ice as well as the airplanes going over it.

There was a period after the time of Leif Ericson when the ice was no deterrent for ships sailing on a latitude line from Iceland to Greenland. It wasn't until around 1200 that the Norse logs showed evidence that ice was forcing them farther south. Gradually an ice period came that was so severe that the Greenland colony was left to wither on the vine and die.

This climatic change that took place at that time is part of a cyclic condition that repeats itself over and over. Since 1900 there has been a continuous warming period throughout the polar regions and throughout the world. This warming period, if continued—as estimated by some for another twenty-five years—would leave an open sea in the Arctic Basin, which would permit navigation across it from Asia to North America. Such a change, of course, would bring about many other things. It already has brought about many changes of considerable interest to the people concerned with food and animal life in the world.

The fishery industry has been considerably affected over the past fifty years. As the climatic change gradually progressed in its warming trend, the currents of the oceans began to deviate, changing in strength and direction. As a result the fishing grounds have shifted. Around 1924 the currents around the southern coast of Greenland began to be used by cod to the extent that in the late war period fishing in southern Greenland increased to the extent that some 15 million pounds of cod were exported from an area which previously had had practically no fishing.

In various parts of the world the same pattern has been seen with fishing grounds changing as ocean currents change their paths. I witnessed down in Chile, in 1941, a great flock of cormorants of the guano type that had their habitat largely on offshore islands near the Equator. These birds had lost their fishing grounds and at least a million or more were dying on the shores around Valparaiso and regions south, a very sad sight to witness. The birds had flown until they had become exhausted and were dropping from starvation.

So as the currents change, they will bring about a continued pattern of change in the economy of the world. If this pattern were to continue until the ice began to melt in the Polar regions of the Arctic and Antarctic, it could affect the entire world and its economy. Even right here, high up in this building, we might be under water were the ice of the Antarctic Continent and Greenland to melt completely. It is not going to happen, I am sure, in our lifetime, but it is indicative that this change of climate also changes the water level and alters human habits and economy.

Even the Eskimo, who followed the fishing grounds and the walrus and the polar bear, has had his problems of changing economy, but the changes have not all been climatical. Many have been caused by the increase of technology. For the Eskimo with a gun, getting his walrus and Polar bear is more simple than it used to be. In the same fashion the availability of fast travel and the influx of tourists and hunters into the far North requires more and more effort to maintain conservation laws extending out into the open waters onto the ice packs in order to preserve animals that could be rapidly brought to extinction simply because man's mobility can take him and his lethal weapons to the spot so easily.

The polar regions are in reality a desert. They are a desert in respect to the availability of water, although there is probably more fresh water locked up in the polar area, than exists elsewhere. On the Antarctic Continent the average thickness of ice is more than a mile deep and in some places more than 10,000 feet deep, and despite the fact that the real continental mass has mountain peaks in some places rising up as much as three miles or more in height, this great continent is a desert. The ice doesn't melt, and because it doesn't melt there isn't enough water available for plant life. Where snow does melt on the sides of the rocks the tricklets of water running down cause such plants as can find a foothold on those rocks, such as mosses and lichens, often to grow profusely. If there is no source of free water, the rocks are sterile, or at least apparently so.

However, the requirements for plant life—sunshine for at least half the year, carbon dioxide, and water—are potentially available for plant life.

However, a different situation exists around the edges of those continents and in the Polar Basin in the north. The richest living conditions for plant life in our oceans exist in the polar areas. According to the discovery report in Antarctica, the plankton count in the seas surrounding Antarctica is some fourteen times greater than that of the plankton count in tropical waters. The plankton, being the base level of life, moves on up the scale of the animal kingdom through the pelagic forms that live on these tiny plants, the small unicellular animals, on into the various forms shrimp, on through to the birds, seals, and the whales, until the greatest of all creatures of all time lives there in the waters surrounding Antarctica—the great blue whale, that grows to a length of over 100 feet and weighs about a ton for each foot of length. These great creatures live entirely on the small crustaceans that often swim in the waters so densely that the color of the water is nearly pink with the color of their bodies. The richness of the life of Antarctic waters is significant not only to those animals that live there now but may at some time become significant to a world looking for an increased food supply. The waters along the edge of the continent are enriched by phosphates and nitrates from bottom deposits churned up by the uprising currents and by the fact that cold water holds more carbon dioxide than warm water, providing an environment more suitable for plant life.

As you look at old sea ice that has existed through more than one polar season, you will find it banded with brown stains. Under a microscope these are found to be tiny diatoms and other small forms of life that have been entrapped in ice crystals. These little creatures were trying to find just a bit of light up through the ice, enough to grow and propagate. They were able to grow by the million, even under conditions in which the temperature of the water remains almost constant. Perhaps the freshening of the salt water caused by fresh-water ice melting into the ocean may, too, have added to the ability of this life to grow, but under such conditions one can well imagine farms of the future dependent directly upon the oceans for a concentration of food products from this source.

I think that if we look at these polar regions and examine their resource potentials, we realize that we must depend upon discovery and exploration to find out what the resources are. In Antarctica the first question people often ask is, "What are the minerals?" The truth of the matter is that the exploration of Antarctica by geologists and minerologists to date would be equivalent to three or four men going around the United States on foot for a year to get an idea of the geology of our continent. We don't know what the geology is. We know that last December a party that was doing a glacialogical traverse through a portion of west Antarctica came close to a mountain range—the Hurlick Mountains by name—between 200 and 300 miles from the South Pole. The party took a few hours off and reconfirmed that this mountain had, as had been found in other spots along the range, great quantities of coal, quantities of coal to the extent that some of the veins were 20 to 40 feet in thickness. The value of this as a resource is not great at the moment, but it does mean that in the future Antarctica may yield mineral wealth, but right now the great value of Antarctica and of the polar regions in the north is perhaps for their scientific yield. Throughout the International Geophysical Year we scooped up great quantities of scientific information from these polar areas by exploring in three dimensions. In the past exploration has been mostly two-dimensional, but this time there was exploration into the atmosphere over the polar regions and down through the snow caps into the rocks themselves and by means of seismic methods finding the characteristics of the whole continent and the world and its structure.

From this data will come, perhaps, a great deal better understanding of the temperate areas of the world in which we live because unless we go into these extreme regions to extend our science, we cannot understand the full measure of the problems that are closest to us.

I think that it is very fitting for a group like yourselves, concerned in conservation practices for North America, to be concerned in conservation practices throughout the world and into the polar regions, which so far have not a great deal of restrictions or a great deal of care taken as to prevent the possible extinction of resources. After the War of 1812 there was a great influx of sealers in Antarctica. They went in very secretly because they didn't want to give away their sealing grounds, and they literally slaughtered the fur seals of Antarctica and the islands surrounding the continent. A little while later, with the need for oil and before we learned how to get oil from the ground in quantities, the oil was sought from the animals of Antarctica, not only the whales but also the seal and particularly the sea elephant, and again another species was almost rendered extinct. Fortunately, there was a limiting factor, the cost and the difficulty of getting to a region. If you didn't come back with a pay load, you eventually had to give up before the very last animals were killed off. It was thought for many years that the fur seal was completely extinct in Antarctica and the surrounding islands, but in recent years on a number of islands around the continent a few colonies have begun to come back. Maybe the process needs to be aided by actually implanting fur seals in regions where they once grew naturally, projects very worthy of undertaking in this day and age to restore an animal that mankind had nearly taken from the face of the earth.

The sea elephants have fared a little better. In some places they are back to the point where they are beginning to crowd the beaches where once these giant seals lived in great quantities.

Whaling is the only industry of the polar regions. It is the only one of the Antarctic—except for postage stamps. The only real conservation practices are the efforts of an international group trying to control the rate of the killing, the slaughter of the great whale. The great blue whale is a prize because a hundred tons of whale yields a tremendous quantity of oil, and nations deal with these animals in different fashions. Some boil the meat to remove all the oil and save the refuse for fertilizer. Other nations, such as Japan, take the meat back for the people and use every bit of it. So the economy of much of the world is dependent upon certain resources that can come from these oceans. It may be more dependent on them in the future.

If we look at our present political situation we find suddenly a revived interest in the Arctic because of scientific and military activities and because of our new state. We find a revived interest in the same way in Antarctica, but there we find that while we took no interest nationally to claim land, other nations were more aggressive and have claimed the bulk of Antarctica, although most of Antarctica, up to 1955, had only been seen by Americans from the air and by ships passing by the continent. Some areas, of course, were seen in small portions by many other nations as well, but other nations made claims even though they had not seen the country, and they made it in a pie-shaped wedge in to the Pole. Anything they saw on the coast they extended on in. At least two nations put claims on in to the center of Antarctica without having set foot on the continent and simply because they extended their longitude line as a means of political interest. The same extension of longitude lines on to the Pole held in the north, the governments saying that, "If any islands are ever found in this region"—and this was at a time when it was a blank space—they would belong to those countries.

The Arctic is all explored so far as blank spots are concerned. Antarctica has a region about half the size of the United States that has not yet been seen. It is a race whether we will see the rest of the world's surface before we see the back side of the moon. But there are other parts of the world we haven't seen, too, and we are awakening to this need, and that is the bottom of the oceans, to increase our interest in exploration of the oceans and along with this will come a great flood of interest in biological factors.

With the increase in travelability, the world is shrinking every day, flight lines going over the polar regions to the north and tourist travel beginning to open in Antarctica. I suppose for a little way into the future the ingress of people going into Antarctica will not seriously upset the animal life, but certainly now is the time to begin to examine it and see how to keep that life perhaps under proper protection and to learn as much as we can of the animal life of the polar regions before civilization begins to upset that condition.

Finally, I would like to take a long look into the future. Although we are at present following a nationalistic policy in looking at Antarctica, if there was ever any region in the world that mankind could get together and administer it would be a region that didn't have anybody in it. This is true of Antarctica and thus the twelve nations that are now, or have been, working in Antarctica are attempting to get together to form some sort of a treaty for the peaceful use of Antarctica. Whether this will succeed will depend on whether the world has actually become capable of solving its problems in this day and age by arbitration and by planning. However, if we think that we are at the acme of the world we have awfully little minds. We must think, of course, away into the future and I can visualize the Polar regions being populated much more densely than they are today, and, perhaps, self-sufficient, self-sufficient in a manner which would take a lot of explanation. But in order to set one's sights high and far into the future, we can expect, perhaps, that by stages we will be able to use those regions to live in.

I know from the experience of living at below minus 100 that there is nothing to stop a man being able to live and exist in those cold temperatures and actually be able to work and carry out industry. It is quite probable that the world will need that space of Antarctica for industrial or scientific purposes, and when it does men will have no difficulty in living or traveling there. Then we will be able to speed back and forth. Only thirty years ago it took a hundred days to get to Antarctica one way. Now you can easily go down and back in a hundred hours. We have had several Congressmen this last year fly over the South Pole and be away from home for only a short time.

One of the steps into the future will probably be getting at the chemical basis of food and resources. When we learn to put together the various elements, particularly carbon, hydrogen, oxygen and nitrogen, which form almost all of the basic food and power and clothing and much of the materials of mankind, there will come a time when man will be able to put these together, perhaps at will, in combinations from which he can make food and other materials that he needs, and under such conditions Antarctica can become just as much a part of the world economy pattern as other regions.

We have entered into a period of endless energy resources. Even right after the war there was a great fright that we would run out of liquid hydrocarbons and coal. Now, with atomic energy and the realization of the untapped sources of great energy in the earth itself, the heat of the earth, the heat from the sun, there is no limit to what man can do in the future to make parts of the world we now think uninhabitable be part of our actual daily living.

So in summary, I leave with you the thought that the polar regions, which once were so ominous, so frightful, so far away, are in reality a very short distance away, only a matter of hours and in some cases minutes away, a region to which some of our interest in animal and plant life has a direct bearing with the changes in weather and the changes in characteristics of the oceans. And so in our worldwide thinking through the excellent sights set by this Conference we can realize that the polar regions are really not far from North America, that they are a source of resources, a future for people, and space that may be needed for civilization.

DISCUSSION

VICE CHAIRMAN HADLEY: Dr. Siple, I am worried about a domestic problem. I have been thinking about your Arctic terns. When a pair of Arctic terns goes from the Arctic Circle to the Antarctic Circle, do they have a problem as to where they are going to bring up their families, or do they do it in both places, or isn't it known?

DR. SIPLE: I am afraid that I am not sure if I know the answer as to which end they do have their families. I think that there are evidences that some of them nest at one end and some at the other. I am not sure of the exact answer. I think there are probably some authorities in this audience who could answer that better than I can.

MR. LESLIE DIX [Department of Defense]: Some three years ago, I believe, Doctor, the Department of Defense was asked, largely for the late Admiral Byrd, to draft legislation which, if enacted, would have established an Antarctic Commission to be established presumably to coordinate and give direction to all Antarctic exploration. Are you familiar by any chance with the present status of that legislation?

DR. SIPLE: I am in part, Mr. Dix. Senator Wylie, of Wisconsin, I believe, has reintroduced the bill, only slightly changed, and it was signed by quite a galaxy of Senators. There have been similar bills introduced into the House. This does call for the suggestion of the development of a Government center for the control, or at least carrying on the interests of the polar regions.

Actually, we have had no Government department that has had this responsibility nor a responsibility over that of other Government departments, and we have lacked this very seriously. Currently there is an Antarctic Office in the State Department for the first time, an office with several individuals attached to it. The Defense Department has protemporary offices in the Navy and various regions carrying on polar interests. Interior, of course, is concerned with those portions of territory such as the former Territory of Alaska, in which it had a very specific interest in the polar regions. This Commission, however, would provide an opportunity to have a central group that would be concerned for the continued interests of the United States, both scientifically and politically.

The scientists themselves held a conference this past year, called by Dartmouth, just before Christmas, and in this there was a discussion of the ways and means of bringing together the great increased interest by universities—a number of different universities have started polar institutes, or polar offices, in groups, carrying out work for both the north and the south.

The Arctic Institute of North America has, of course, been extremely active in this same type of thing, interested in trying to bring together the non-Government interests of the polar region and in reality the Arctic Institute of North America realizes that no longer is the Arctic the only polar region, so they are about, as I understand, to change their name to the Polar Institute of North America.

And finally, the Academy of Sciences has its program in polar research as an advisory to the National Science Foundation, which at present is carrying out the program of the various Government departments in science in Antarctica and the basic interest within the Government is very strong. A lot of money has been going into these regions, but there is undoubtedly a need for a bill something like the Wylie Bill covering a means of having some organization for polar administration.

MR. EARL FRYE [Florida]: I have a comment to make about what we are seeing in the papers, most of which points out the techniques for supporting a large human population. Some of us wildlife people who live in areas such as Florida wonder if we aren't missing the boat on this thing, if there should not be more attention given to some method of stopping this human population growth. All we are doing is postponing the inevitable.

This is no place to argue about the Mathusian principle, but there are some other angles, other than just building up as many resources as possible to build up a human population.

VICE CHAIRMAN HADLEY: Is your question directed to Dr. Siple or to Mr. Bennett?

MR. FRYE: It was neither. It was a comment. [Applause]

VICE CHAIRMAN HADLEY: Does Dr. Siple or does Mr. Bennett wish to make any comment? Mr. Bennett!

MR. BENNETT: Well, obviously, the techniques for what you would like to do are not within my scope of comment but I would like to point out one thing. This, I think, sometimes goes to the very root of the comment that you had in mind:

The assumption has been many times that a smaller population will live better than a larger population. Of course, history demonstrates that many great empires have existed on the face of the earth, but when their populations began to decline human ingenuity and the vast variety of human thinking became less prevalent and those nations deteriorated and oftentimes fell.

Now, without going into specifics, I think some of you perhaps can think of relatively modern nations which have gone through periods of decline when at the same time their populations were declining, so it seems to me that the point has never been proven that a declining population means better living for those who live within the confines of a nation.

THE LAW AND PROGRESS IN CONSERVATION

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I. THE LIMITATIONS OF LAW

One of the first cases presented to students of the *law of property* at law school, in my day, related to wildlife. The case was that of Pierson against Post.[1] Mr. Pierson was a hunter. He shot a fox and wounded it sufficiently badly that the court found that it would have died in a few hours. Mr. Pierson was pursuing the blood trail through the woods when he came upon Mr. Post who had found the fox lying down and had seized it. Mr. Post refused to relinquish the fox to Mr. Pierson who claimed that, having shot it, and being in full pursuit, it belonged to him. The question before the court was: what constitutes *possession* of an animal "ferae naturae"—free by nature. In its wisdom, the court propounded the *doctrine* that "possession exists when the obstacles to manual seizure have become negligible." I do not recall who won out.

This case is a good introduction to the vagaries of the law. In reading some of the more recent cases involving disputes over water under the appropriation system of the West and the riparian system in the East, we find, even today, a similar sort of equivocation.

Without law, disputes may well result in violence; and yet, law is not synonymous with order. We can only wish that by wise laws we could bring order to resource use. There can be quite as much conflict over what are wise laws as there can be over what is wise use of resources.

Even though the law of property has advanced far beyond principles such as that laid down in Pierson against Post, and become much more certain, the trend today is again in the other direction.

[1]Pierson v. Post 3 Caines (N.Y.) 175, 1805.

Charles Haar of the Harvard Law School has stated the matter thus: "The law of property has taken on the characteristics, both advantageous and disadvantageous, of constitutional law. The trend is from relative certainty to what may be termed inchoateness, as the field of property has developed from one, technically called private law, into another, called public law. This change from a law primarily covering property relations between individuals to one in which the basic interests of society must be reconciled (such as the impact upon property of the exercise of the eminent domain and police powers) has important consequences. Precedent is weaker and predictability is reduced, replaced by the somewhat hazy field of constitutional generalities, of value judgments, and "countervailing forces."[2]

There are laymen who believe that laws can provide overall policy, or overall plans, to advance the conservation of resources. They object to the splinter approach. But even in the early days of our nation, De Tocqueville disparaged overall legislation when he said, "General ideas are no proof of the strength, but rather of the insufficiency of the human intellect; for there are in nature no beings exactly alike, no things precisely identical, no rules indiscriminately alike applicable to several objects at once."[3]

When there are substantive and substantial differences among men as to what is the wise use of resources, and when we consider the complexities involved in multiple use, we can recognize the difficulty in providing overall laws to govern resource development. This is why the law deals in principles such as that laid down in Pierson against Post, rather than seeking to settle finally issues which are seldom clearcut. This is also the reason why there is a considerable degree of speciousness in the thinking of those who believe that the law, if "properly enacted," could assure wise resource management. There is a vast difference between laws that seek to establish national or state policy and create administrative agencies to carry out the policy, and laws which seek to compel, or prohibit, or regulate the cutting of trees, or the number of trout that may be taken in a day, or the number of ducks of one kind or another that can be killed in a year. The problem is to achieve reasonable flexibility within sound policy.

II. CONSTITUTIONAL LAW

There are, of course, many kinds of law, even as law has many purposes. Constitutional law deals with principle and authority, human rights and checks and balances. It is fundamental law in that

[2] *Boston University Law Review,* Volume XXXVI, Number 3, p. 333.
[3] Alexis De Tocqueville, *Democracy in America* 13 (Bradley edition, 1946).

it cannot be modified without extended process.

The Constitution of the United States, and its amendments, exist through ratification by the several states of federal powers, and executive, legislative, and judicial functions, conceded by the states, with reservation to the states of powers not specifically granted to the federal government. It is the states that are united rather than all the people of the nation. It is interesting to speculate whether the best interests of our people are served by the present political and geographical boundaries of the states. If the people today were to determine new and ideal political and geographic boundaries of local unities which could still be united under a Federal constitution, reserving to those unities local political, economic and social powers, would we not have fewer states? And would not these new unities be based perhaps on river basins as a whole, with possibly a number of large metropolitan areas with common interests that today extend across existing state lines? I say it might be interesting to speculate on this because it is obvious that no such radical change in the Constitution is likely to occur until resource pressures significantly increase and become recognized as controlling economic and social factors in the future welfare of communities.

The economic and social influence of natural resources presented no significant problem to the states at the time the Constitution was first drafted; but times change, and resources do now present significant problems which we are seeking to solve, in part, through inter-state compacts, valley authorities, metropolitan councils, and other instruments of organization and law which are not inherent in the state-federal relationship so carefully defined by the drafters of our Constitution. As these pressures and problems increase through the years ahead, it is conceivable that the time will come when our lawmakers and our conservationists will be considering together the nature of long-range changes in constitutional thinking about the political status of unities such as river basins and metropolitan areas. Such unities may well become the bases of national representation and local government. We might even begin to ask ourselves *today* how sacred and how economically and socially essential are geographical and political boundaries which now constitute our 49 comparatively jealous and autonomous states.

III. ADMINISTRATIVE LAW

Administrative law is much more flexible than constitutional law. Administrative law and administrative procedures have grown up through the years, federally and locally, to meet convenience and expediency, and without consideration of interdependence. It is submitted that the resource problems that exist today in many jurisdictions require extensive revision of antiquated law and regulation. And yet we should not act too hastily.

Regulation of resource management, including wildlife, forest, range and wilderness management, habitat control, and watershed development is presently in an evolutionary stage. Even laws that seek to establish and define long-range policy remain controversial; and certainly there is little agreement about the best legislative provisions for governmental organization for resource management.

On this subject of organization there is the basic quarrel in almost all jurisdictions over the degree of centralization desirable for the administration of interdependent and interrelated resources. The advocates of centralization rightly say that separate departments, bureaus and commissions dealing with specific resources become so concerned with their own specific problems that they lose sight of interdependence and multiple welfare. Opponents of centralization, backed by special interests, maintain that under centralized administration legitimate special interests will be neglected and valuable uses subordinated to the generality. Yet decentralized organization imports diversified legislative committees, diversified budget consideration and appropriations. This leads to duplication and conflict, extravagance, and delay.

A first-rate discussion of these problems can be found in William Schulz' book entitled *Conservation Law and Administration,*[4] which was a case study of law and resource administration in Pennsylvania. In the introduction he says:

> "Integrated conservation planning that recognizes the unitary nature of the conservation problem is one of the vital contributions that law *can* make but one which is lacking under present legislation. At all levels of government in Pennsylvania, the management of water resources is treated as though it were only slightly related to the management of the grass and forest cover on the watershed, and as though it but slightly affected the management of fish and game. Yet even a novice in this field quickly comes to realize that, as a practical matter, every action with regard to one natural resource has an impact, delayed or immediate, upon every other natural resource. This principle should be the foundation upon which all legislation and administrative organization is constructed."

Professor Schulz appended to his book a generalized model law which has been used as a point of reference by legislative bodies and

[4] Wm. F. Schulz, *Conservation Law and Administration,* Ronald Press, N. Y., 1953.

committees in a number of states, including Alaska.

The problem of the best form of government organization for unified *river valley development*, including construction of large and small structures to control the flow of rivers and their tributaries, the distribution of water and land-use practices in the uplands, is still largely unresolved. Interstate compacts are not rare, but they are difficult to effect and rarely effective because of the local jealousies involved and the sparing delegation of authority.

Creation of the Tennessee Valley Authority seems to be recognized today by many students as a highly successful approach to organization for resource development and the improvement of prosperity in an interstate river basin. Unfortunately, it aroused and continues to arouse anxiety and fear on the part of conservative forces in the nation who glorify local rights and conceive the Authority to be a dangerous anomaly under our constitutional system.

Few people comprehend the huge number of agencies and groups concerned with one or another phase of water management affecting a great interstate river and its tributaries. For example, there are more than 263 local agencies vested with more or less responsibility for the management and use of the waters of the Delaware, and there are many federal agencies also concerned with that river. By centralizing authority, and centralization is necessary where multiple demands for water already exceed the supply, the responsibility of many agencies is bound to be curtailed. And that means trouble! In any legislative process which seeks to deal with so complicated a problem, compromise is inevitable. Even with compromise, something better than existed before may be achieved; but for optimum development and use of water throughout a basin, central authority is essential; compromise on this issue spells failure, the kind of failure we will not be able to afford in the long run. It is this fact which underlines the prospective need for change in our political and geographic unities which came into existence without consideration of the need for control of major water systems throughout the nation.

IV. ANTIQUATED LAWS

Most laws related to resources are hardly adaptable to the pressure of modern demands. The law of water rights is a notable example. It is well known that in the United States two principal systems of water law have evolved. The doctrine of riparian rights, in the East, was largely a laissez faire doctrine which assured to the owner of private land "reasonable use" of the "natural flow" of streams on which his land bordered, and which percolated beneath his land. In an era of plenty this doctrine sufficed, with a minimum amount of litigation between individuals. As new uses and demands for water have increased through the years, including major public and industrial uses, the doctrine has become inadequate.

The law of allocation, in the West, is likewise becoming antiquated for the needs that now exist. Priorities under the Western law now have to be altered. The granting of permits and licenses has become an extremely technical function of governmental bodies, and rights previously acquired have now to be changed. A major problem in modernizing water law throughout the nation involves the subordination of existing rights of individuals to the public need, and the manner by which compensation for those rights can be provided. Another important problem is that of assuring the security of new investment in the private development of water. There is work here requiring collaboration between students of law, technologists, and conservationists.

V. CONTROVERSIAL MEASURES

Technical advisory services and financial incentives provided by law are new means of advancing development of watersheds, soil conservation, range management, and crop controls. All of these are controversial and influence conservation progress for better or worse.

There is much still to be done. Many of us believe that the present laws providing controls over the use of poisonous chemicals as insecticides are inadequate. Some interests would like to see modification of the Taylor Grazing Act. Others want to legislate sustained yield management of private as well as public forests. We are still fighting for the principle of wilderness preservation as a national policy; we need to speed up rehabilitation of the public range. Rules and regulations of our conservation agencies have the force of law. We still do not know how best to fix hunting and fishing times and limits; or regulate predation; or what should be the extent of air and water pollution control; or the limitation of billboards. In a very important opinion the Justices of the Supreme Court of Massachusetts recently extended the purview of the police power to include aesthetic purposes.[5] Recreation facilities have long since become inadequate, but how can we at this late date best acquire rights to land that will be needed for recreation and other conservation uses in the distant future. Few lawyers agree.

Since laws are made by representatives elected by the people, and since laws can be changed for better or worse, it remains important that the people be constantly aware of the implications of resource policy and of the manner by which it can be translated into action. Not only conservation, but the law of conservation is everybody's controversial business.

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[5]Opinion of the Justices (Mass.) 128 N.E. 2nd 557, 1955.

VI. LAND USE IN THE WELFARE STATE

There are some souls who purport to believe that the use of private land should be publicly controlled in the interest of conservation. They do not consider what minds would be competent to exercise such control, or what assorted interests might thereby be excited to violence. The notion springs from increasing talk about exploitation, urban sprawl, regional plans, and land-use zoning. They do not appreciate that every control of private land use is a restriction of individual freedom.

Nevertheless, we do in fact find more and more restriction each year on the uses of private property as population and industrialization crowd the land. Too little thought is given to our growing need for recreation, for space and clean air and blue sky, without which Walt Whitman said "democracy will dwindle and pale."

Urban sprawl, that creator of megalopolis, now reaches across state lines and raises new problems of both law and government. Zoning under the police power is one legal tool invoked to meet the crisis. But the law is confused by the demands. Land-use planning, transportation, airports, water systems, power, factories, housing, schools, parks, recreation, all assert demands. How can we, in the face of sprawl, conserve resources and human rights and public welfare? Can new concepts of law evolve fast enough, and soundly, to meet these problems? Suffice it to say here, in the words of Charles Haar:

> "Out of this restlessness and growth, the pressures of different interest groups, and retested experience will emerge, one may hope, a further rationalization of land law policies. Recognition that even the oak of property law bends in the wind does not necessarily identify change with progress. One group upon whom has fallen a major job of reconciling the diverse values and of achieving the most efficient allocation of land resources is the legal profession. The challenge is great and alluring: granted the need for city planning, how may reason be used in formulating policies; how may intelligence be applied in the choice of goals, means and priorities? How do we work out an organization of society both efficient and fair in dealing with property concepts?"[6]

These questions too will be answered, if they can be answered at all, by lawyers, planners, and conservationists working together.

VII. INTERNATIONAL LAW

International Law and International Conventions have played a significant part in resource development and distribution. So, of

[6] *Boston University Law Review*, supra, p. 336.

course, do international trade and technical assistance, which are products of the legislative process.

Protection of wildfowl high over the borders through international conventions, and the conservation of fisheries on the high seas, while not perfect by any means, indicate that nations can and will cooperate for the welfare of all. The United Nations sponsored the first major international meeting of technicians concerned with all kinds of world resources—the UNSCCUR meeting in 1949. And the International Union for Conservation of Nature and Natural Resources is a more recent gesture toward common understanding and action which deserves far greater financial support from member nations.

I now submit to you an approach, through law, which seems to me to hold out an extraordinary hope for progress in world resources development and distribution, and indeed a hope for lasting peace in the framework of one world. It is based on the concept that through increasing world-wide recognition of the dependence of all men everywhere on the raw materials of earth for common survival, lies an incentive to international cooperation not found in political and ideological or power approaches, which seem today to block international agreements. As populations increase and industrialization spreads to less developed nations, and the demand for raw materials now exported by the latter increases at home, the struggles to possess adequate raw materials will either have to be resolved by International Treaties, to increase world production and productivity and equalize distribution for the common good, or they will be resolved by force in an age of atomic destruction.

The nations have not yet found a way in law to federate and become one world. This is somewhat strange in view of the knowledge of the values and potentialities of flexible constitutional procedures, and in view of the will of peoples to better human welfare. It is not love of the idea of sovereignty alone, or of racial or even religious chauvinism, that precludes progress toward one world. It is economic rather than political fear that holds the world apart.

What is at the root of economic fear, which perhaps the long experience of law can help resolve? I would suggest today that one of the roots of economic fear—and perhaps the most decisive taproot of all—is the unequal scarcities of natural resources which are essential to national prosperities. Each nation is dependent on *imports* of various vital resources, as well as on the resources it possesses itself, to maintain a minimal prosperity and safety. Here are roots of jealousy, as well as fear, that keep the boundaries of nations armed.

The search for greener pastures, the history of the bursting forth of have-not peoples (who failed to conserve what they had at home) to conquer and consume the resources of the more conservative "have peoples" (who may have become soft in their having) is constantly in the minds of leaders of nations where populations and consumption are growing fast, and scarcities increase. I submit that the disposition and indisposition of resources are at the root of economic and material fears that keep the world divided. Perhaps, then, a world treaty that would provide for a pooling of effort to attain optimum yields of all the world's resources, and flexible but optimum distribution thereof, may be a touchstone step in the direction of one world—and world-wide conservation.

This may seem to you a revolutionary idea. But is it any more impracticable than the early idea that 13 divergent and far separated colonies in America could ever pool their diversities, their ambitions, their animosities, and their resources for a more perfect union?

Let us look at the practicalities. It is stated by many authorities that even with three billion people in the world, there are sufficient mineral and organic resources recoverable annually from the earth and sea by use of technologies now practiced in some place or another, to raise the level of living of all men to a state of modest luxury. This is not to prate of Utopia—some men will always waste and some will hoard, and some will seek more than their share. It still takes law to police human conduct everywhere. The fact is that this world's resource *potential* is sufficient; its distribution system and its political system is wholly inadequate. The plentiful life can be obtained only by world pooling of the resources of the Earth under international law and one world organization for distribution under law. It is not that resources and their conservation are the supreme end in themselves—human values are the supreme end—it is that the incentive of plenty for all, through world union and world law, is a quite possible approach to unity in the world of tomorrow.

I have referred before to the difficulty of arriving at effective interstate compacts here at home to provide for the development and distribution of the multiple benefits that accrue from unified and centralized administration of great river valleys. Is there then any reason to believe that international rivalries, jealousies and chauvinism are more likely to be subordinated to the salvation of world welfare than are the jealousies of a few American states, counties and municipalities anent a river valley?

Strangely enough, I think the answer is "yes." There are factors of compulsion in the world scene which we do not have in the Delaware or the Columbia Basins. There is the "have not" factor, the inherent danger to the more prosperous ways of life from the desperation that grows with hunger and denial in crowded lands. There is no such dangerous compulsion inherent, as yet anyway, in our own basin disunities. And there is the factor of plain humanity.

It is easy enough to believe that some governments, some sects on earth, and even some races of men, have no respect for the individual and can never be moved by humanity—by which I mean: by a compelling sense of responsibility to improve the conditions of their own people and of people everywhere. Certainly the Union of Soviet Socialist Republics, and the Communist leaders of China are both very much concerned indeed with the health and the productivity and the satisfaction of their people. They may use what seem to us repressive and enslaving methods to accomplish what they are sure is going to be—indeed must be if the leaders are to survive—the betterment of their peoples' condition. We must not confuse methodologies with the will to human progress, which I believe exists everywhere despite the apparent frequency of repressions, crimes and pogroms. For all of man's cruelty to man—and we can find examples of that right here at home—there continues to be a recurrent, irrepressible movement forward toward greater human welfare, a movement nurtured by all of the great philosophical and religious communions of mankind.

We are not going to have peace in our time, one world, through chauvinistic negotiations and approaches of the past, or through power politics and national vetoes. But we may open the doors to peace in our time through an interhuman need for a pooling of the resources of the earth, for their universal and common development, and their controlled distribution.

We have already made two starts. First, in the age-old system of barter: if you have something I need and I have something you need, we swap. This, with infinite economic and political complexities added, is international trade. The United States in the last fifty years has had to import more and more raw materials from other lands—and certainly with our growing population and industrial expansion we are going to want to import much more in the years ahead. We are going to give away in return much more of the wealth we can spare, and ultimately a lot that we won't like to spare. But would we not all agree that we would prefer to see our own prosperity somewhat lessened to avoid atomic warfare, and at the same time raise the levels of living of other men? Necessary trade is an approach to the pooling of resources.

Next, we have made a start by way of technical assistance. This assistance could be far greater if we did not have to assist ourselves and others to build up and maintain military force "as a deterrent to war." Technical assistance aims at better development and better productivity of natural resources, and at industrialization. If we can avoid the temptation to impose our own ideology and sometimes quite boorish foreign way of life, along with the gifts of technology, we are taking a long step down the road toward resource sufficiency for the many, instead of the few.

We should note, also, that it is not only the Western powers who are providing technical assistance toward resources development. The Russians also are embarked on technical and materials assistance programs, which of course provide reciprocal benefits to their own economy, and increase their trade, employment, and political kudos. In fact the idea of international cooperation to increase the agricultural, industrial and technological production of less developed nations—is accepted strategy and may well be turned, in course of time and necessity, into acceptable *international ideology* as it becomes a widely used economic and social (as well as political) practice of both camps.

The aim of such common ideology that could lead East and West together—toward one world—is to increase the availability of world resources and so to increase levels of living and *world* prosperity. With each increase in living levels anywhere, there is an increase in education, in trade, in research and technology which will raise standards elsewhere. The aim is to start and stimulate a peaceful cycle of prosperity. It is not a matter of price and wage inflation, but increased productivity, and thus of human levels of living which in turn initiates an upward spiral of prosperity for all. To *fight* for resources that are scarce, and destroy them in the process, is a sorry alternative.

How might we progress now from these first steps that have been taken? An international law could be proposed—a convention to which any nation might subscribe (to avoid negotiation with or recognition of the unrecognizable). It could be accepted by East and West, the Arab nations, Indonesia and all neutrals too, because no one will be asked to give up ideology, or sovereignty, or territory, or anything they hold so dear. The law would call for a pooling of technical assistance programs under U.N. administration, with member contributions proportional to those made to the support of U.N. today. The law would create a constructive world partnership to raise production and productivity to a sustaining optimum, and to distribute the increased product from a pool, under formulae to be stated in the law and interpreted, if necessary, by the World Court.

Obviously it is the formulae for distribution of additional and surplus production that will be difficult to state acceptably to all. But formulae have been worked out for the distribution of water in many river basins whether under a Master or an Authority, or a Commission, or the Supreme Court. A method is not beyond the ingenuity of men with a will to advance world welfare and peace. I think it can and will be done.

Of course any international law or treaty providing for distribution can be divisive as well as collective. Nations can seek to wreck the law. Tariffs can alter an entire distribution system. Imports of certain materials, raw or refined, from one or more geographically or politically foreign states can be discouraged, by making them too costly. Law can lock up certain resources in certain places and for better or worse make them unavailable. Surpluses can be bought by governments and either hoarded or bartered or given way for political and social purposes.

The people, through their representatives, can legislate prosperity or famine, free trade or prohibition, war but seldom peace, insularity or one world. But nations can also declare war and be done with humanity. I believe that an International Resources Law will be more collective than divisive.

I offer no blueprint here, nor am I suggesting a Utopia. I repeat only that resources and law together provide an approach, an incentive approach, a comparatively painless next-step approach to world conservation progress and toward one world as well. The common dependence of all men on natural resources which, mutually developed, can support a favorable way of life for the many, offers a reasonable *hope* of achieving peace in our time and our ultimate hope for one world.

DISCUSSION

MR. R. A. BROWN [Missouri]: There is one aspect of water litigation which most lawyers and judges have completely ignored or overlooked—Mr. Ordway knows what I am talking about; I see him smiling. In Missouri we have an Act of Admission. Now, this could be extremely important for all these states. When we were admitted as a state in 1830 our Act of Admission specifically provided that the rivers Mississippi and Missouri and the navigable streams and the waters flowing into them and the carrying places between "shall forever be free and open to the people of the several states" and all of our early constitutions adopted the identical same lines.

Now, there was a water case in Missouri in 1954 and they brought the theory that a stream to be navigable was measured by the term "navigation" as used at that time, therefore navigation meant that if a stream was navigable by canoe or by a small boat it was navigable water and it was public water and if the Constitution says that water must always be open to the various people I don't believe the legislators can pass laws. You will get into some very serious constitutional questions.

Now, I know that most of the western states have Acts of Admission. Iowa has. Kansas I am not sure about. I have never checked it back East. But there is a problem which could loom very large and it could be used **to balk** disadvantageous legislatio**n. It ought to be looked into in all the states.**

FACING UP TO OUR WATER PROBLEMS

S. L. FROST[1]

Assistant Chief, Division of Water, Department of Natural Resources, Columbus, Ohio

This is a case of a substitute substituting for the substitute. When Mr. Browning, over a month ago, asked if I could take his place, I said yes—because I looked forward perhaps more than anything to renewing my acquaintances with friends with whom I have long lost contact. Also these institutes have been valuable goldmines of information. But then the floods hit Ohio and we have been pressed into emergency surveys. I felt that my first responsibility was Ohio, and regretfully I had to bow out. So with my greetings to you may I wish my substitute good luck on this venture.

When I called Mr. Gutermuth about the topic he had assigned Mr. Browning, I told him I was no water authority. Also, that we couldn't single out "clean water" as a part of a water program for America, without touching many other facets.

"Pink" said: "That's OK, Jack. Tell the story as you see it."

This is that attempt.

Our water problem today revolves around a great triangle. At one point are people with their needs and desires. At another are their governments—local, state and national—created to assist in meeting those needs. At the third point rests the question of money, or the way to finance the improvements needed.

That may be a tremendous oversimplification of this whole problem. In fact when you think about it a moment, you will be quick to say that same combination applies to the building of roads and schools and to about any other line of public endeavor today.

You will also immediately recognize that the same basic triangular concept can be stretched from a small local water problem to a much more complex state, national or world-wide situation.

How we fit and juggle our various levels of government assistance, and our ability to pay for the things we want, to satisfy the needs of our people, has been, for the water resources field, the subject of long and continuing debate and often bitter controversy. On this battleground we have tried, rather unsuccessfully, to hammer out a national water policy.

Other than the fact that water policy itself is so nebulous and subject to the pressures of people and their legislators, one of the difficulties seems to lie in the fact that we have perhaps failed to grasp

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[1]In the absence of the author, this paper was read by Mr. Ollie Fink.

some of the fundamental truths about water itself as a resource.

Moving as it does through Nature's fascinating hydrologic cycle, water is not a resource that we can box up acre-by-acre like land, trees, grass and minerals. Nor can we destroy water, and deplete its supply, in the same sense that we mine out minerals. Neither can we consistently increase the supply, as we can grow more trees and grass.

Water is a resource constantly in motion. World-wide we have as much now as we had millions of years ago. But the quantities made available to us from the skies above constantly change and shift from place to place, and from time to time. These extremes of distribution fall and rise, like the crescendos of a great orchestra. We can be knee deep in floods, or bone dry from droughts, in the same year in the same place. This too much-too little water combination reminds us of the Texan who was seen rowing across the flooded street in his town to collect his government drought disaster check.

Just how to deal with this fickleness of Nature has been, and always will be, a real puzzler. This involves a drama of tremendous proportions. Its stage is world-wide. Here we would need to learn how to harness and control the air masses, weather and rainfall. Perhaps as our scientists gradually draw back the curtains of mystery still surrounding our universe, mankind may emerge as the master of Nature. Until that day is reached, we must seek the answer elsewhere.

Let us say for now that there is no way by which we can legislate rainfall. No way by statute can we turn the faucet on and off from the skies above. No law, no matter how skillfully drawn, creates water.

Somewhere in between our inability to pass laws to make it rain, or stop raining, lies the answer to a better water future.

What is this future, and how do we approach it?

In peering into a crystal globe of such magnitude we need to better clarify what we mean by our water problem.

Water can mean many things to many people. To many, it is identified as the problem of supply—the water we need for cities, homes, industries and agriculture. To others, it is the problem of floods and drainage. To others navigation, or recreation—and to many others the problem of quality of water, and pollution abatement. We can add other problems to that list—as for example, the whole relationship of land to water. Because we are human beings and act like we do, it has been a common practice to fracture this water problem into each of the above segments. You will immediately recognize that we have as many different interest groups and stacks of legislation as we have water problems. The reasoning for this approach is readily recognizable in the way our interests and needs have ebbed and flowed with the changing crisis of water.

For example, great droughts in Ohio in 1953 and 1954 started the state on a long-range problem of developing a plan for new water supplies. Last month we were hit with a $100,000,000 flood. Now the hue and cry is for more flood control. Raising, lowering and changing these water problems flags makes the formulation of any water policy as capricious as the display of weather warning flags at our Coast Guard stations. As helmsmen at the wheel, water resource administrators find it almost impossible to keep the water policy ship on a steady course.

What is this course?

Fundamentally, it would appear that any water policy must recognize that water has to be controlled and managed so as to best serve the needs of mankind. To be effective, this policy needs to be designed, and so adaptable, that it can be workable where people need it. It cannot effectively succeed by championing one interest over another. It furthermore requires a basic knowledge of water behavior.

Up to this point, we have only discussed water behavior in terms of rainfall. An equally interesting part of this problem is what happens to the water after it reaches the ground.

Through the ages of time, Nature has etched out the courses of streams and rivers. Each tiny tributary, each stream, each river has its own catchment basin, or watershed. Our watersheds thus divide our supplies of rainfall. Depending on their size, their topography, their geology, temperature, land use and types and condition of their soils at the time of precipitation, each watershed develops a water delivery character of its own. By continually gaging and studying the record of streamflow, we can gradually determine just what the ranges of streamflow can be, within the limits of rain delivered to it.

Every water improvement we make, whether for water supply, flood control, drainage, power, navigation, recreation or pollution abatement is determined on the water delivery character of its watershed area. Try as we will, we can't escape this truth. Our watersheds thus become the all important link between rainfall from the heavens and mankind's use and control of water.

How unfortunate that we have fractured that link by such simple, unassuming devices as lines on a map called political subdivisions! But those political boundaries stand today as one of the great problems of effectively finding a way out of our increasing water dilemma. Here we find the interesting analogy of mankind fighting against himself. Dependent on effective watershed control, he has surrounded himself with so many political barriers, that he finds himself in a continual struggle to break through a vastly complicated web.

Realistically, we can't go back to the Eutopia of washing out our political boundaries. So how do we do the next best thing, and that's to live with the mess we have created?

Back in 1914, following disastrous floods which wrought great destruction in the Buckeye State, Ohioans masterminded the Conservancy District Act which permitted superimposing on a river basin a new government taxing structure with powers to permit groups of political subdivisions to jointly plan and develop flood control improvements. Born as a local venture, with no assistance from the State, citizens in the Miami Valley fought through years of litigation between themselves before they had finally completed their $30,000,000 flood control improvements. Later the great Muskingum district came into being. By that time too, state and federal assistance was available. So contrasted to the local financing accomplished in the Miami, Muskingum Conservancy was developed almost entirely with funds from other sources.

It is ironic that the Ohio Conservancy law, conceived to provide watershed management, with its later revisions to include water supply, recreation, drainage and pollution abatement, and copied by many other states, has not been used more widely in Ohio. It still has many weaknesses, which lawyers now are trying to correct. The weak link in it still is how to get political subdivisions in a watershed to work effectively to finance and construct water improvements.

This problem is not one common to Ohio alone. There are problems, too, in the concept that watersheds must be locally administered for the benefits of the people in the watershed. That may hold true for many of our watershed approaches, particularly flood control. But it has a lot of weaknesses in it when we think in terms of water supply.

In many states, we are finding mushrooming metropolitan areas spreading their sprawling suburbs over several watersheds. Is local watershed control the answer in such areas? We also find "have" and "have-not" watersheds. For example, northern California river basins have tremendous supplies of water but relatively small needs compared to the great demands in the low water-yielding areas in the southern part of the state. Huge water transportation systems are being planned, spanning great distances to solve this problem. Los Angeles for years has had to look to watershed areas far removed from its environs for supply. No locally administered program by the people living within such watersheds, can solve these problems.

The concept of river basin and watershed control must be flexibly applied, depending on the particular problems in each area, and the needs of the people.

Here in Ohio we have been working three years on a water plan inventory. We have found water supply is becoming an increasingly difficult problem—not because water is scarce, but because of the rising costs of securing it, and then—after using it—the expense of adequately treating it before return to our streams and lakes. Finances loom as the No. 1 headache. Unless we are smart enough to lower these cost barriers, we visualize some rough times ahead.

Problems contributing to this dilemma in Ohio are the growth in municipal water supply systems—from 172 in 1900 to 625 today. We think one of the answers is fewer supply systems—more wide-scale regional and watershed developments, efficiently managed to lower costs and wholesale water to more using areas. These same developments would handle the problem of sewers. We likewise visualize the need for a system of reserving reservoir sites while they are still available, more pipeline developments, and eventually more diversion of water between watersheds.

Our studies of water use have shown a net consumption of only 10 percent of daily water withdrawals of over 12 billion gallons daily. This means that tremendous quantities are being returned after use. Therefore, pollution abatement is as important a part of water conservation as building new supply sources. Thereby we reuse water many times.

We have also found in Ohio something like 48 agencies assigned by law with some kind of water authority, not to mention our 625 municipal water agencies. There's an old saying that what's everybody's business is nobody's business.

Where then, do we go from here?

First is a direct assault, and that is by the states themselves. Each state has a tremendous opportunity to exert a new and dynamic leadership in formulating water resource policy for its own citizens. This policy then needs to be supported with money, and finally by aggressive programs of research, planning, and development. If need be, the states can even assist to the extent of creating, by State law, watershed districts, and providing assistance in managing them. This would help to answer some of the problems of water diversion, that will ultimately arise.

State water resource activity, with but few exceptions, has been a weak sister compared to other state natural resource conservation effort. Expenditures reported to the Council of State Governments in 1954-55 fiscal year, exclusive of pollution control and wildlife developments, totalled only some $24,000,000. Only a few states have ventured into the field of water development—an activity generally left to the federal or local governments.

But there are signs of a hopeful emergence of state activity since 1955. Here are some of the highlights:

—*9 states* have created new water resource agencies since 1955. 4 others reorganized existing departments.

—*More than three-fourths of the states* passed important new water laws.

—*California* has completed a state water plan. Has upped appropriations for its Water Resource Department from $4.6 million in 1955 to $14 million in 1959.

—*New Jersey* authorized $48,850,000 bond issue for state water improvements. Appropriated $100,000 to start underground water explorations.

—*Texas* appropriated $1.2 million to its state water agency to start state-wide water plan. Voted constitutional amendment authorizing $200 million in bonds for water improvement projects.

—*Connecticut* has recently consolidated its several water agencies into a water resources commission; enacted a flood plain zoning law to be administered by the new commission. Appropriations have been upped to $1.5 million, plus another $2.75 million for state aid in flood zoning and construction.

—And many other states have special water study commissions at work.

Second: Greater federal participation, with particular consideration to studying the feasibility and means of cooperative financial assistance with the states on programs of water development and pollution abatement. Such a program might be worked out similar to the patterns of cooperative federal-state highway construction and forest fire control. Such financial participation should be on a matching basis as a stimulus and incentive to state participation.

Third: A nationwide program of citizen education and their participation in water resource programs. Broadly conceived, such effort while working at all levels of government, should stress local effort. An enlightened public, with inspired leadership, can be the greatest force around which to marshall a frontal attack on every phase of water resource development that we can envision.

Fourth: A broadened program in our colleges and universities of training water resource managment engineers.

Fifth: A National Water Congress to be called by the President, with the Governors, their staffs and selected individuals to draft in open meeting a program of water conservation for the United States.

The similarity between the idea of a proposed water congress and the American Forestry Congress of 1908 will be readily recognizable.

These recommendations are only one man's opinion. There are many more which others can add. But the opportunity and challenge to face the water problems ahead are tremendous.

We can never hope to fit everything into a perfect pattern—or to reach agreement on a total water resource program. But by defining those areas of agreement and by constant public debate on other issues we can move constantly ahead. In the meantime any effort is better than no effort.

GENERAL SESSIONS

Tuesday Morning—March 3

Chairman: ELDON L. JOHNSON
President, University of New Hampshire, Durham, New Hampshire

Vice Chairman: HENRY CLEPPER
Executive Secretary, Society of American Foresters, Washington, D. C.

BILLION-DOLLAR QUESTIONS

OPENING REMARKS OF THE CHAIRMAN

ELDON L. JOHNSON

Ladies and Gentlemen of the Twenty-Fourth North American Wildlife Conference, the Second General Session: As an educator who has been struggling recently trying to get a million dollars from a reluctant state government, I have already fallen in love with this title today. We in the university business are accustomed to dealing with thousands of dollars and occasionally millions, but never billions, so I come to this subject without the handicap of experience about the problems and without prejudice as to the amount involved.

But, seriously, we are here assembled to discuss something which too many take for granted in an age of missiles and rockets and tranquilizers. The good earth we take for granted and man's relation to nature, except, perhaps, nowadays nature in outer space.

This audience understands that error, but we do have billion-dollar questions, not just on the agenda but on the way to action and solution. I understand a responsible national organization suggested not long ago that we need to plan for the next ten years to spend three billion dollars for putting the forests in productive shape, four and one-half billion dollars for erosion control and watershed protection, one billion dollars for western range lands, two billion for recreation facilities and another billion for wildlife refuges. Now, whether these are the right figures or not, the point is clear that we do have resource problems, and critical ones, in the billion-dollar category, billions in needs and billions in benefits. We have problems of the correction and control of man's use and man's abuse of nature.

HAVE WE A CONSERVATION CONSCIENCE?

MONROE BUSH
Assistant to the President, Old Dominion Foundation, Washington, D. C.

The United States owes as much to the wealth of her land as to the intellectual wealth that was imported from the Old Country. Ideas and principles alone could never have made this country great. That there was space enough for everyone, that there was natural wealth to spare, are fundamental explanations of the American saga. Let us never underestimate what the natural supplies of the earth have meant, not only and obviously to our American economy, but to our political, social, and cultural life.

Nowhere is there a better example than in this country of a great civilization growing literally out of the minerals and the humus, the climate and the rainfall and the space of its section of earth. Yet I doubt that this has been understood very clearly, and certainly it has not been understood very widely.

Now our present situation, *vis-à-vis* this central belt across the continent which we call the United States, is simply that our resource consumption is rising—and seldom have so few words implied so much.

The United States would consume larger bites of her resource wealth each year, even if the population were to remain static, for the one reason of the continuing climb of our living level. But we know with regret that the population is not static. The population is bursting yesterday's forecasts in rampant growth.

So startling is this growth, both per capita and per capita consumption, that it is impossible to make a fifty-year projection of resource needs with any reasonable accuracy. Repeatedly these projections must be revised upward; repeatedly the facts outstrip the forecasts.

This being the case, we come to the urgent and timely question: "Have We a Conservation Conscience?" The first thing is to define our terms.

"Conservation" is the effort toward a permanent balance between human need and natural supply. The physical requirements of society must be met from the resource-reserves of the natural world, but met in a way which, while fulfilling the needs of the present, will also assure the maintenance of this reserve for the future. And the word "future," let us never forget, is a long, long word!

This is the goal of conservation, this balance, but obviously an ideal goal which cannot be attained in full. The realities of life restrict us to the hope that we scan move toward it—which I just phrased as an "effort toward a permanent balance."

Now what exactly do we mean by such terms as natural supply or resource reserve or natural resource? We refer, obviously, to the wealth of the earth: to (1) unrenewable supplies such as coal and oil and horizontal space; to (2) renewable supplies such as soil and water, and the plants and animals which exist in an ecological relationship to these; and to (3) aesthetic reserves such as are found in wild, beautiful nature, unadulterated by man.

Our "conscience" toward the conservation of these resource reserves can be defined as concern motivated by idealism. Within our context, therefore, conscience is an attitude of responsibility for striving toward a permanent balance between human need and natural supply.

The question is: Have we such an attitude in this country?

Obviously, there *is* such an attitude among some people—each one of you is a witness to it. Obviously, there *is not* such an attitude among many other people. What we must determine is whether the conservation conscience is dominant in American society, or whether it is submerged beneath other attitudes that are antagonistic or indifferent to it.

From the earliest settlements to the present, the illusion has persisted in America that space and natural wealth are inexhaustible—or virtually so. This illusion of the American cornucopia is a refrain that runs throughout the whole of our national mythology. It springs not only from the vastness of the country in contrast to the mere handful of initial settlers, but from our inherent optimism. As a society we have been confident of our virtues, of our power, of our rightness, of our good sense—and most of all, confident of our good luck.

Immersed in this tradition of optimism and confidence, the people have, for the most part, had little inclination to question the cornucopia. They have not wanted to do so. They have shut their ears to the experts whom they call alarmists.

Born and nurtured by optimism, people are not apt to get excited by the spectre of falling water tables as long as water flows from their bathroom faucets; they do not tend to despair at the shrinking saw-timber supply as long as they can buy two boards for shelving; they are not going to become greatly concerned by the decline in horizontal living space as long as they can buy homes within an hour's drive of the office or factory.

There is absolutely no evidence to support the contention that a majority of the citizens, or even a small but noticeable minority, are intelligently and consciously hopeful that this country will move toward a balanced accounting of its natural wealth.

If we were to add all those who belong to any sort of conservation organization, and all who can read and understand a newspaper account of resource economics, and all who within the past twelve months used the word "conservation" at least once in a conversation —if we were to add all these, the total would be but the smallest fraction of the audience of the poorest Western on television.

We cannot honestly pretend that the American people, as a people, have a conservation conscience. If we are going to think strictly in terms of numbers and percentages, the answer to our question must be a resounding "No."

Yet within the past fifty or sixty years, astonishing steps have been taken by this nation to conserve some of its resources, in some places. The state and national parks, the state and national forests, the wildlife sanctuaries and the constructive hunting and fishing laws, the growth of sound commercial forestry, the increasing conservation of the soil, the wiser management of water—here are real victories. To be sure, the war is not won. The war will never be won. But these are battles within the war, and they were won. Insofar as each represents the triumph of a sound conservation principle over an unsound exploitive one, each battle was a victory for the conservation conscience. In ten thousand specific instances this conscience, while never enjoying majority support, has been dominant. The reason is simply that there exists a small, dedicated corps of resource specialists who, with endless personal effort and sacrifice, manage to make the conservation conscience dominant in a tremendous, complex society of which they are, numerically, but the smallest fraction.

And this is my chief point: the conservation conscience can be dominant in American life from time to time and place to place, without once representing a conviction on the part of a majority of the people.

This is inevitably the best for which we can hope. The mythology of the cornucopia goes too deep into our folklore to be dislodged by mere facts.

Where there has been no such mythology, on the other hand, the story can be quite different. The most conspicuous examples of a conservation conscience are found in those countries where a high degree of civilization must make exorbitant demands upon an insufficient supply of land and land-wealth. When human need far outstrips the easily available natural supply of resources, it is not uncommon to find a tremendously intelligent, energetic effort underway to raise the natural supply toward the levels of the need.

This is true throughout much of Western Europe. It is true in the forests of Sweden and on the farms of Japan. Obviously the quality and success of these efforts vary with local culture and the local industrial economy. Unsatisfied resource need does not, of itself, assure an effective conservation conscience—as evidenced by mismanagement of the natural supply throughout the West Indies, for instance, and Central America. But these are exceptions in degree only, and in the main the case seems to me very clear that the greater the imbalance between social need and natural supply, the greater the conservation conscience.

Coming back now to home shores, and to our initial question, we find evidences of this same situation. When something is in very short supply, such as the whooping crane, there is a tremendously intelligent, energetic effort to safeguard and, if possible, actually increase the supply. When something is relatively abundant, such as western land, there is only a feeble and faltering concern for exploitive uses which do not immediately or noticeably affect society's limited present needs.

A small New England town can generate a powerful conservation conscience toward the preservation of its elms. Vast tracts of distant timber, on the other hand, may have few voices raised in their defense.

In this country, as in the world over, people are excited by what they can see and by what affects them, by what is close-at-hand and obviously urgent. Facts, taken in themselves, have seldom stirred the hearts of men, anywhere.

There is no mystery, then, in our circumstance. The people do not have a conservation conscience about the large and essential resources upon which American society rests, because they have neither seen nor felt the depletion of these resources. They have seen the elms die on their streets; they could not see the depletion of southern saw timber—and what they could not see, they did not understand.

We cannot expect the people, in general, to awaken until the problem of resource management becomes critical; and by that time, it will be too late, and it will not matter whether they awaken or not.

The work of the conservation conscience must, therefore, be made dominant in all areas of American life without the benefit of majority support from the people. The effective discharge of this conscience must, in fact, be intended to prevent the people ever awakening to the problem, for it is intended to prevent the problem becoming acute enough to awaken them!

The great strides made in resource management since the turn of the Century indicate that many times and in many ways the conservation conscience has been dominant: in the halls of the Congress; in the offices and agencies of the White House; in the national press; in the councils of the unions and of industry. But never has this dominance been attained by the active and knowledgeable support of a majority of the people.

The people neither proposed nor opposed these efforts. Improvements in resource management have been proposed by a handful of dedicated experts, and opposed either by a handful of special interests, or by merely a vast and pervasive ignorance and lethargy.

Here then is the spectacle of public issues, some of them affecting the economy and the very social stability of this nation for generations to come, being fought to decisions "in the wings," so to speak, off stage—noticed by few people, understood by few people.

I have said that the people will not really care concerning resource management until there is a gigantic crisis in the resource supply. This is true. But people can be educated to understand an issue about which they may not care deeply. They can be informed, even if they cannot be enlisted.

And this is the challenge before these leaders and experts who, today, possess within themselves a conservation conscience, who literally are the conservation conscience of this country. These to whom the nation owes so much must find a way to inform, to publicize, to "spread the word", so that increasing numbers of the people will understand the issues, whether or not they have convictions concerning them. Through such information they will develop a conservation understanding.

This is our only realistic goal: to multiply many times over the numbers of Americans who have a conservation understanding. We cannot expect them to join the battle. They are not pushed by circumstances; they are not personally threatened by those shortages which shall plague this entire nation fifty years hence. It is unrealistic to insist that they have the sort of conservation conscience that the dedicated expert embodies; we should be more than happy to settle for a conservation understanding.

With the spread of such an understanding, those who fight the resource battles will no longer be ignored "in the wings", but will then stand full-center on the stage of national attention to explain to people who now understand the issues, what it is they are fighting for.

Let every man, therefore, who lays claim to the least spark of a conservation conscience, pledge himself to do all that he can with his brother conservationists to inform the people, to publicize the issues, to achieve among the people a conservation understanding.

DISCUSSION

VICE CHAIRMAN CLEPPER: Those of us who are familiar with the writings of Aldo Leopold and Gifford Pinchot and some of the latter-day conservationists who have so eloquently discussed the aesthetics of the movement to which we are all dedicated—I am thinking of people such as John Baker, Sigurd Olson, Clarence Cottam, Howard Zahnizer, and Harold Titus——realize that the address we have just heard is certainly in keeping with the tradition of the ethics of our movement and we thank you very much, Mr. Bush, for bringing this message to us.

MR. ALDRICH [Arkansas]: That was one of the finest talks on this particular subject I think that it has been my pleasure to hear.

Since I am in information-education work, the thought occurred to me, hearing those words information and education used frequently, it might behoove more of us to give a little more attention to those departments and divisions and perhaps try to give them a little more just recognition. Secondly, we know that informing is educating. We try to get the conservation message before the public, but I wonder if we make the effort that we should through public dissemination. We all realize that in this business of conservation we don't get the space and we don't get the time that some of our spectator sports get. I would just like to throw those two things out for thought if anyone cares to pursue them.

VICE CHAIRMAN CLEPPER: Mr. Bush, would you like to comment further on that?

MR. BUSH: Just to say "Amen."

VICE CHAIRMAN CLEPPER: Inasmuch as Mr. Monroe Bush will have to leave, I have a question addressed to him from our mutual friend, Howard Zahnizer. Howard has laryngitis today and has asked me to read the question. His question is as follows:

> Do you think of there being such a thing as a national conscience? If you do, do you think that the idealism of conservation is becoming part of our national conscience?
>
> My thought is that through our media for communication of ideals, churches, schools, civic groups, periodicals, books, a responsible attitude toward the natural world is becoming part of our sense of duty, our sense of what is right. This may be the development of a conscience, a conservation conscience and it may be an acceptance of conservation programs comes or will come from this sense of duty or conscience as well as from a sense of providence or self or group interest.

MR. BUSH: That is a hopeful question, Howard. You are more of an optimist than I am when you speak of a national conscience developing. I personally think it would take considerable optimism to see any development of a national conscience in this country in regard to anything. There are consciences, to be sure. We have our blind spots and some of us have a conscience in respect to "A" and a blind spot in respect to "B" and a different one in respect to "C"—and so it goes.

I do not share your hopefulness, though, toward the development of this national conscience. I don't personally see the development in concurrence with that of the sort of conservation conscience of which you spoke and of which I was speaking earlier. There is such a difference between an informed and intelligent conscience and mere sentiment. It is conceivable that nationally the people might have sentiment regarding, for instance, the preservation of the park system. The man in the street might have a real sentiment toward this, but whether it would be conscience in the sense that I was using the term, or to speak of the dedication, the informed dedication and lifelong zeal of people, I would question. You can have a sentiment this morning and have forgotten it this afternoon. The kind of conscience that I was trying to talk about is something that would be very, very deep in the spirits of people and it seems to me that this is still limited to the sort of group you have here today. Thank you.

MR. J. SHOMON [Virginia]: I would like to offer simply a little comment and perhaps raise a point or two.

I have a background in forestry, professional forestry and professional wildlife. I have been in conservation educational work for more than nineteen years. The older I get, the more I try to see the thing in the clearest perspective, the more I find how little I know.

I would like to come to the defense of the biologists. I believe they have been criticized a little bit and perhaps they haven't properly informed the public of what is going on. I am wondering if we are in some ways overspecialized and if we have become overspecialized, whose fault is it?

It is generally conceded, I believe, that people stay away from the things that they do not know very much about. The business of informing is largely in the area of communications arts. If the biologists and specialists in general have not been told about the communications arts or the value of the communications arts it is going to be a little bit difficult to have them do a great deal of work in that area. I just mention that as a thought.

IS SCIENCE SERVING CONSERVATION?

HIDEN T. COX

Executive Director, American Institute of Biological Sciences, Washington, D. C.

Mr. Chairman, ladies and gentlemen. I need not expand upon how privileged I consider myself to be invited to participate in this panel discussion. At your New Orleans meeting I was asked to be co-chairman of one of your sessions. Unbeknownst to you my co-chairman and I grew up together in houses set side by side. We had lost track of one another and this happy occasion was a reunion for us after some 25 years. At your St. Louis meeting I was honored to be included among your otherwise distinguished guests at the head table for your banquet. Today I shall contribute what little I may to your deliberations and it is indeed a signal honor for me to be here. I accepted this invitation primarily because my being here symbolizes, as it should, the essential unity of all the biological sciences.

Despite my obvious pleasure at being with you, I must confess that I have been, and still am, frightened at my inadequacy in speaking to the specific subject assigned me. I am not a trained conservationist and I disavow any intention of trying to tell you how "fundamental biilogy" has or has not failed in its responsibilities to the wildlife conservation disciplines. I would rather start with the unarguable premise that the study and practice of conservation are integral parts of biology and indeed impinge upon very nearly all other branches of the science. This thesis accepted, I shall then restrict myself to certain comments on the place occupied by biology in our present-day civilization as I see it.

I make the flat statement that biology has contributed more to the philosophy and the comfort of mankind than any other science. If documentation be needed it is easy to provide. What minds have had more impact upon man's understanding of himself and his world than those of Mendel, Darwin, and Linnaeus, to name only three? What other group of scientists has contributed so much in food, fiber and shelter to an ever-increasing standard of living by an ever-decreasing number of producers of these basic necessities? What other science can claim achievements of a profundity equal to the virtual eradication of communicable diseases? What other fields of scientific research offer a more exciting challenge or the possibility of more rewarding results than those concerned with the exploration into the workings of the mammalian brain or with the synthesis of living substances in the laboratory. One need not apologize for biology—past, present or future—as an intellectual activity eminently worth the dedication of men's lives in its pursuit.

I could follow this line of exposition for the rest of the time allotted me. I can continue reciting accomplishments of biologists for an hour or so and on occasion I have done just that. Such a nice, innocuous speech extolling our virtues makes none of us mad and leaves us all bathed in a warm pleasant glow of self approbation.

But there is another side to the coin. In my opinion we biologists have failed miserably in one critical area of our responsibilities. We have failed completely to convince—or even really to inform—people of the value to human welfare of biology as a science. Sometimes I think we are not convinced of it ourselves.

Consider with me the following—shall we say—brief of argument:

Most recent studies agree that upwards of 80% of high school students take a formal course in biology. This is a significantly higher proportion than take other science courses offered. It follows then that the general public appreciation of what biology is and what biologists do should be greater than that of any other science because more people have been exposed to biology as a formal course offering. The facts, though, refute this conclusion resoundingly. Examples:

1. By and large biologists receive lower salaries in federal Civil Service employ than most other scientists.
2. Generally speaking, representation of biologists on national, policy-making scientific committees is lower than it should

be, based upon the importance of the field or the relative number of workers involved.

3. In certain federal agencies devoted to the development of science as a whole the amount of funds going into biological research is lower than in other disciplines.
4. Literally billions of dollars are spent annually on fake medicines and quack doctors, reflecting the fact that millions of people are ignorant of even the most basic essentials of human physiology and anatomy.
5. The current deplorable race tensions are traceable directly to a lack of understanding of human relationships.
6. According to the National Society for Medical Research about 6,000,000 adults in the United States are unalterably opposed philosophically and emotionally to the use of animals of any kind in any sort of laboratory research and another 6,000,000 or so will side with them more often than not in voting for legislation restricting the use of laboratory animals.

I do not believe I overstate when I say that the lay person's ignorance of biology and its contributions is appalling. I believe that the blame for this deplorable situation may be laid squarely at the door of professional biologists, in short, you and me. How have we failed?

There are about 100,000 professional biologists in the United States. They have organized themselves into at least 80 professional societies no one of which has a membership of over about 15,000. The chemists have concentrated in one strong and vigorous society which dates from the late 1800's. The physicists are a little more diffuse in that they are divided into about 6 societies. However the physicists developed a progressive, central, all-inclusive group about 30 years ago. The comparable group in biology—the American Institute of Biological Sciences—can trace its history, by straining, back to 1948, but as an independent voice of biology controlled directly by biologists, its history before 1955 is nil.

In brief, therefore, biologists have not been able to speak in unison before the last 4 years. In the last 4 years the AIBS has tripled its membership and multiplied its annual gross income by 20 times. As a scientific organization it probably ranks first in number of members and no lower than third in gross annual operating budget. This growth has been paralleled by its growth in prestige and influence. It is the one and the only biological organization today with the potential to speak and work for biology and biologists at the national and international levels.

Can it do so? With one—and only one equivocation—my answer is a firm YES. YES, if the biological community will support it completely and unhesitatingly. YES, if all biologists will join it and support it financially. Today about 80% of all professional biologists belong to the AIBS but only $1.00 of every $50.00 in the AIBS annual budget is contributed by biologists. In the field of public information the AIBS spends not one dollar of direct funds. Until this calendar year one of our sister scientific organizations annually appropriated a sum of money for public information which was larger than the entire AIBS budget and which was 9 times larger than the amount of money contributed to the AIBS by professional biologists. Need another reason be sought to explain why the average person has little or no concept of what biology does for him?

Nevertheless, we biologists *are* making some headway. The AIBS has started two monumental projects designed to improve the teaching of biology at the educational levels where the great majority of persons are exposed to the science. The future should show a gradually increasing respect for and appreciation of biology. And this brings me back by the most circuitous possible route to the original topic of my talk.

What we are now at long last doing is not yet enough. Biologists have a responsibility to inform the public of our contributions that is no less great than our responsibility to carry out researches in the first place. An informed and appreciative public will place demands upon us—pressures upon us—to do things that we should have done long ago. Who among us now can say what will be the effect of dumping radioactive wastes in the oceans? Have we any reliable knowledge of the food potential in the seas? Have we ever applied systematically the principles of genetics in forest management? What would happen to us if the highly refined strains of cereals were to be wiped out overnight by disease? These and other questions remain unanswered or can be answered only fuzzily because clear-cut answers have not been demanded of us. An informed public will demand them as they now demand satellites second to none. When that happy day is reached fundamental biology will be serving well the fields of conservation, and medicine and agriculture. It will be serving humanity.

DISCUSSION

VICE CHAIRMAN CLEPPER: Thank you, Dr. Cox.

Our speaker on several occasions has disclaimed being a conservationist, but I submit to you, after having heard his address, that if he is not already one we are sure on the road to making him one.

DR. HAROLD COOLIDGE [National Academy of Sciences, Washington, D. C.]: I would like to raise the point on this paper of Dr. Cox's that it seems to me that the whole science of ecology is one in which scientists can contribute tremendously to the whole field of conservation and I don't think that the possibilities of building up interest in ecology have been pushed sufficiently by the biologists.

I know that in our efforts to further the development of national parks and natural reserves in various parts of the world one of the things that we need most is to have competent ecological studies made of these areas, and when we are dealing with problems of a vanishing species one of the first things we need is to have some ecological studies made of the last remnants of these vanishing species before they are entirely gone. It would seem to me that more effort might be developed to interest biologists in having their students undertake ecological studies that would have direct benefits to conservation programs.

DR. COX: I couldn't agree more with what you say, Dr. Coolidge, and I think you will be interested to know that one central theme of the course that is being developed on film is ecological.

The study group agrees with us and determined that that was a basic framework upon which this high school course would be developed.

MR. ALDRICH [Arkansas]: My thoughts are in the field of conservation.

Dr. Cox, you made the statement that an informed public would demand the services of biologists and scientists, with which I think we will all agree. This may not be a fair question, but do you have any reasons, or do you have any thoughts as to why it is that so many biologists feel that these things which they are concerned with are none of the public's business?

DR. COX: I don't think I would have stated it quite as strongly as you did. I think that historically among biologists there has been a tendency toward a sort of introversion, if I may use the word. Most biologists that I have known have felt that their work is of interest to them, a selective group, but has not been of general public interest and they have shunned the opportunity of telling what they are doing, of interpreting what they do, in the light of human culture and philosophy. This, of course, is the point that I was getting at, I think it is the fault of the biologists for not having translated into human affairs the importance of what we are doing and it is high time that we started doing it.

MR. W. D. ROBERTSON [Mississippi]: I would like to ask Dr. Cox for a little fuller explanation of what will be in these films, whether they will be made will they be available?
available to teachers in schools and at shops and if so approximately what date

DR. COX: You pushed a button which ordinarily sets me to talking for about fifty minutes on the film course. I will try to restrain my enthusiasm, though.

First, this film course will be ready by September of 1960, if we maintain our schedules and so far we have. It will be a complete course with a base of 120 films of about thirty minutes' duration. The number 120 was chosen to allow the showing of four films a week for approximately half the period and leaving the fifth period of the week vacant for laboratory discussion or whatever the teacher wanted to schedule. There will be another 40 films that can be inserted in spots along the course of the other 120. This reflects our desire to make the course as flexible as possible so that a teacher does not have to follow a prescribed 120 lessons but can mix it up a little bit.

Secondly—also following out on this philosophy of flexibility—the course, unlike the physics course, does not have to be purchased in its entirety. Units can be bought and shown. The course is based upon about eight units and there is some interchangeability among the units so that each unit actually more or less stands on its own and a teacher now giving a good course in biology—and there are many doing that—who feels that a certain part of his course offering could be strengthened by these films, can purchase only that portion of the course.

Further than that, following up again on this idea of flexibility, a single film may be purchased, or three, or five, however many the teacher feels that he needs to help him teach biology.

And finally, one of the interesting things about this course is the fact that we have demanded and are getting about 20 per cent of the film time spent out of the classroom. There will be film clips inserted. These film clips will be made on the scene about which, the teacher, is talking. For example, when he is talking about marine biology there will be inserted clips of films taken of marine fishes on the reefs off Florida or when he is talking of desert flora and fauna, there will be scenes of actually what he is talking about. These insert clips will be marketed individually so the teacher can just get the insert clips, if that is what he wants.

So it has built into it as much flexibility as possible.

The entire course can be purchased by school districts for the use of teachers, for the use in classrooms, or in any way they want to use it.

MR. OLLIE E. FINK [Executive Secretary, Friends of the Land, Ohio]: Having had a good bit of experience in conservation education, I think it might be appropriate here to relate the statement of a biology teacher which I think was a very significant one. I was a director of a conservation laboratory in Ohio for the training of teachers, and we had a biology teacher come down from Toledo, Ohio, who was a very superior teacher. She had been teaching in the Toledo high school for a number of years and there happened to be in her textbook a chapter on conservation. There was never enough time in the course to cover the entire book so that was one of the two or three chapters which she always omitted, but after she had been to the laboratory for two or three weeks she wrote a letter to the superintendent of schools in which was this sentence, which I think is very appropriate for all of us to remember. She said:

> It is surprising how a subject takes on importance with one's ability to teach it.

DR. JOHN BAKER [New York]: A production of 120 thirty-minute films presumably with sound track costs quite a bit of money. My question is, who is putting up the money for these productions?

DR. COX: It certainly does cost a good deal of money. Now, the money is coming from two sources. The part that the AIBS plays in it is being financed by a grant from the Fund for the Advancement of Education. The part that the AIBS plays is to say what goes into the course, to choose and hire the teacher and his assistant and to develop the framework of the course, which we are doing by a series of group meetings of committees of specialists. All of those expenses are coming through the AIBS from the Fund for the Advancement of Education.

As to the actual production of the films, you could divide it this way: What goes before the camera is the function of the AIBS; from the camera back is the production cost and that production cost is being absorbed by private enterprise. We are now putting out to bid—if you want to call it that—to five different interested companies to see which one guarantees us what we want in the course, and, frankly, which one will put up the most money for it. The amount of money is rather considerable, but doesn't mean a great deal because of the different production schedules and methods of procedure of the various companies. Some companies can do it cheaper than others. But the great bulk of the cost is coming from private enterprise because they feel they can get a normal amount of return from it.

IS CONSERVATION EDUCATION FAILING?

WILLIAM C. BRAMBLE

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This is a suggested topic that proved so intriguing it was accepted as given. It is obviously a double-barreled question in that by giving a simple "yes" and "no," you are caught somewhat as in answering that old chestnut, "Have you stopped beating your wife?" There is no way to escape scott-free with a simple answer. However, I am taking the position that the answer is "Yes"; and I believe this is unquestionably the true answer, although this may lead to the observation, "Why are you educators not making a success of conservation education?" Certainly it has been with us a long time and in some quarters, at least, a great deal of money has been spent upon it. On the other hand, if the answer were to be "no," the conclusion could be drawn that all is well and no further steps are needed. Such complacency would lead to disaster; so let us proceed with the "yes" answer with all humility born of a share in the failures as well as in a few successes.

At this point a definition may be needed to start us off on the same foot. We should be thinking alike, at least for the moment, even though many of us may differ in our acceptance of the various definitions which have been applied to conservation. Of these, I have accepted the most commonly used and simplest which would define conservation education as teaching of the wise use of natural resources for the most people in the long run. Admittedly, there can be a great many hair-splitting deviations from this simple definition, but I believe we can all understand what is meant. Also, I will further simplify the matter by considering only natural forest resources of interest to wildlife management. These may be concisely summed up, somewhat as has been done for the three "R's" in education, as the four "W's": wood, water, wildlife and recreation. You may notice that I've taken similar liberties with the spelling and pronounciation of the words.

Education for wise use of these basic forest resources is essential to keep our nation strong in the current competitive international situation. Failure creates more than an academic problem. Many visitors returning recently from the USSR have reported the practical approach that the Russians have been using towards their economic development and it has been summed up very aptly by a newly-returned engineer as "putting first things first." And you can be sure among the "first things" has been developing and conserving natural resources. An interesting recent development in this connection that is of significance to us has been the reported use of cheap newsprint by Communist countries as a means of gaining influence in Asia. Through this means they have used wood, a resource product of the forest, not only for propagandizing the peoples of that part of the world but also for gaining a superior place in the trade situation. While the USSR has a vast forest resource, we also note that a great deal of this fine paper that is going to the Asian peoples comes from the free world and is simply reshipped under the communist label. A new angle in conservation?

Another and more localized reason for education in wise resource use is to meet the threatening population explosion that is predicted for this country. A 60 percent gain in population has been predicted by 1980; and we can well imagine how natural resources, which are now in good supply, will be extended to the limits not only to meet our own needs but to keep us competitive in the international picture.

Another preliminary point to be made is that conservation education, as it is handled in universities, emphasizes how to read, to learn and to understand the principles involved so that educated people can make their own decisions on policies to be supported. It is absolutely not a propagandizing effort in favor of any one line of thought or action. We, in the universities, are very sensitive to this point, particularly in budget years, and I believe have, in general, held the line very well, even though individual professors may be somewhat opinionated.

A need to get conservation education into all levels of schooling was recognized by the first Chief of the Federal Division of Forestry, B. F. Fernow, early in the history of resource conservation. He addressed a circular shortly after his appointment in 1886 to educational leaders as follows: "schools of every grade, without departing from their program work, can supply some practical lessons in regard to the object and use of forests. . . . In colleges, forestry should be presented in lectures on its various relations to arboriculture, agriculture, and political economy." How close we have come to that ideal in the ensuing 73 years can be judged by taking a close look at some of our efforts in conservation education today.

To judge the extent of our failure in conservation education, it will be necessary to examine this activity at its several levels, the first of which we might consider is the precollege level. Here the teenager whose behavior is reputed to be one of our greatest national problems, appears to be in almost complete ignorance of conservation ideals; and the teaching of the conservation ethic of Aldo Leopold appears to be a lost cause among them.

It is a wise conclusion of a few educators that to bring conservation education to grade and high school children successfully means educating more teachers in resource conservation. It cannot be done solely by legislation or by pamphlets and brochures, and its need is emphasized by the remarks of one prominent educator, who observed recently, that he had been "horrified" by the material taught in the name of conservation to most school children. Although at least 12 states have required conservation education in the public schools, this undoubtedly cannot be done effectively unless more efforts are put into advanced teacher training in subject matter. Unfortunately, only few states have worked conservation education into teacher training. A good example of what can be done is found in Indiana where conservation courses are a requirement for training in biology teaching. This should be followed by graduate training in line with the recent proposal that graduate schools offer subject matter courses to teachers in advanced training rather than committing them to piling up course upon course in education techniques through lack of subject matter courses open to non-majors. Conservation education should be made to rank high as a subject matter course by offering good basic resource courses to teachers at the graduate level.

One of the really bright spots in conservation education at the precollege level is 4-H extension work with our rural young people, and more recently, with youth in the urban sprawl. While these agricultural programs have been traditionally involved with raising of corn and bringing prize steers and hogs to show condition, conservation education is becoming a prominent part of 4-H in a few states. In Indiana, for example, the conservation projects, which include both forestry and wildlife, outnumbered any other field during 1958 and reached some 15,000 young people. Conservation contests were statewide and it was a real sight to see the row upon row of completed projects on wildlife and forestry exhibited at the annual State Fair. Here is the real way to teach conservation, by getting young people to actually do something and to learn by accomplishment rather than simply having ideas poured into them through an educational funnel.

At the college level, conservation education is failing to be a normal by-product of existing elementary courses which is what it must be in order to reach a significant number of students. The recent educational trend toward general education and in developing the "whole man" seems to have ignored the vital relationships of man to those natural resources which so greatly influence his life. Admittedly, conservation education is strong in applied resource fields such as wildlife management, forestry and soil conservation. These students, however, are few in number compared to those that should be reached at the college level. Unfortunately, several universities that have tried to develop general elective courses in this field have met with failure. At one university where the general conservation courses are very successful and has a population of some 60 students per semester, a close examination reveals that about 50 of these students are foresters required to take the course and the other ten are those going into biology training! Very few liberal arts students elect a course in conservation, a condition that can only be solved by educating academic advisors in general education curricula.

A real advance in the college-level field has been made through recent conferences that have been held by the Conservation Foundation which is headquartered here in New York City. These have focused the attention of educators for the first time on just what is being taught under the title of conservation education in major universities. And, strangely enough, this simple fact has been an unknown among educators. The conferences, although affecting a small group of persons directly, have hit at many key points and the analytic approach to an appraisal of the strength and weaknesses of conservation education at the college level taken at these conferences has had a strong influence on the conservation education thinking of a number of key people. Another evidence of progress is the recent granting of $154,000 from Resources for the Future, Inc., to the Joint-Council on Economic Education for a three-year program to extend and improve the teaching of resource use and conservation in public schools. Although this may go down the same drain as many other funds and wind up in a Report, it could have considerable effect on leading towards a solution of the problem if some of it would be directed towards teacher training.

A most important educational level that we must consider in this discussion is adult education. This is the latest big thing in university circles where magnificent buildings have been erected to teach everything from how to maintain and activate a volunteer fire company to improvement of theologians, both interested in fire. Conservation education at the adult level has failed to convince landowners and farmers, and many agricultural economists, of the real value of the woodland in rural economy. One evidence of this failure has been a series of small woodland meetings held over the country by agents of the U. S. Forest Service during the past year. One report is that they have found out only what needs to be done and not how to do it. A vital mistake made in such adult programs has been by not going to the local people who are really experienced in this field. For example, the state extension specialist in forestry has been a leader for many years in dealing with the farmer, and is being by-passed. Unfortunately, most states are under-staffed in their resource extension program and are making slow progress. Thus, a study made in northern Michigan found that in 1954-55, 82 percent of the forest owners didn't know that the extension specialist existed, and 97 percent of them didn't know that a service forester was available. Even 93 percent of the Soil Conservation Service cooperators thought the woodland either was not important or occupied a minor place in the farm plan. Ninety percent of the farmers had never heard of the ACP payments for improving forest practices. While this is true in the field of forestry, in the field in wildlife management extension work is practically non-existent so that the situation is even worse and doesn't even merit a study as its faults are well known.

One of the groups that we have failed to reach in conservation education and worthy of special mention are the agricultural economists, particularly in the Midwest. Strangely enough they still leave the farm woodland out of many of their management plans and are only now discovering "that this is a fertile field for development in areas where agricutlure is relatively non-productive." For example, a form entitled "Our Farm Plan" used at a recent conference lumped "Woods Waste and Farmstead" in one category as non-productive! The recently-developed Rural Development Program offers some promise to build up conservation education in this field; but lacks good guidance and support in the resource fields to be successful to date.

At the state conservation level, many departments have failed to educate not only the public, but even themselves, that good habitat management is the key to good sport hunting. As a matter of fact, very little attention is paid to research findings, and there appear to be more experts on game commissions than are coaches present in the bleachers at a Saturday afternoon football game. A recent study of the state conservation magazines in the country revealed while 41 states produced such magazines, six percent of the feature articles were on conservation education and five percent on conservation philosophy. Only 11 of the group presented material that appeared to be based on established research findings. There are some very fine state conservation publications, and of these Minnesota, Michigan and New York stand out above the others in good coverage and realistic approach.

This failure in adult conservation education is not restricted to the state and federal bureaucrats. The industrial groups are finding there is a real problem in educating the public in hunting and recreation on their lands. Restrictive signs simply result in more pressure for public ownership and use brings abuse and lawsuits. One survey has shown that people thought less of forest industries in 1956 than they did in 1952 and that 50 percent of the teachers and 40 percent of the general public interviewed said that lumbering operations were harmful to wildlife. How to get wise use on their lands is one of the top problems of industries that own millions of acres of wildland in the United States.

At the management level we are failing to get the multiple use concept across to many state administrations, mostly politically controlled, as well as to large segments of the general public. Strangely enough, this concept is not at all new. In 1913, one of the first Master's degrees granted in forestry in Pennsylvania had as its thesis, "The Salmon National Forest, Its Resources and Their Relation to the Community." It was a study of multiple use. Recent activities of single-use groups that vie for priority and exclusion of other uses, offer one of the most serious threats to present day beneficial conservation policies. The wilderness enthusiast upon arriving at the top of a remote peak in one of the western wilderness areas and finding evidence that someone had been there before him that week, remarked that his entire trip had been ruined. Even the Indians weren't so privileged as this type of person expects to be. Surely he couldn't expect to have the exclusive use of a mountain.

Good examples of the results of education in multiple use can be found on the national forests where wood, water, wildlife, recreation and grazing are blended, or are appropriately zoned where intensive and threaten to interfere with one another. The national parks also are examples where recreation use is promoted while preserving natural features. Here, too, zoning is necessary where heavy use has created an artificial environment, but, where light use occurs, nature is relatively undisturbed.

Thinking back to the thesis on the use of the Salmon National Forest in 1913, it is interesting to note progress. In 1958, a timber management plan was drawn up for the Salmon River Working Circle of the Nezperce National Forest in Idaho. Timber production is to be coordinated with other uses for maximum multiple-use. Recreation values are to be preserved by not permitting logging across streams and preserving stream-side strips. Primary recreational areas will be zoned off and a special recreational area set aside in an especially scenic area known as Seven Devils. Over ½ million acres are made part of a primitive or wilderness area. Timber and wildlife production will be harmonized by such measures as clear-cutting timber in small patches to produce scattered food and low cover over a large area. Also, by protecting trout streams from disturbance by cutting or roads, the latter will be used to open areas to game harvest and help balance the population with food. Special measures will be taken on timber sales and other areas to reduce flood and control water quality. Thus the U. S. Forest Service which has just recently produced the billionth dollar in wood income will also produce other values in wildlife, water, and recreation.

To sum up, we have the picture today of general failure in conservation education on one hand over-balancing the few successes on the other. "Fail" is used here with the meaning "to miss of attaining." In other words, we are falling short of our desired goals and objectives and any complacency based on certain successes will be our worst enemy for we must either expand and improve or fail. Nothing really stands still; it either goes ahead or backwards. The poet Goethe, who is probably much over-quoted, nevertheless has left a message which I believe applies here today, "What you inherited from your fathers, earn over again for yourselves or it will not be yours." The effective way to improving conservation education is clear. Improve and expand our local successes and take advantage of the experience of those who have been waging a battle against odds. National programs must be geared to operate at local levels and then, if properly financed, will be a realistic approach to success.

DISCUSSION

MR. A. B. TOWNE [School of Natural Resources, University of Michigan]: I am not sure that I got Dr. Bramble's point clearly when he said that we would like to give students the facts and let them make up their own minds. Now, at what level of education would you apply that with your students? How soon are they able to make up their own minds?

DR. BRAMBLE: Let me start by saying that all teachers are opinionated, some more so than others, let us face it, in their classes and if they weren't we wouldn't want them. A man without an opinion isn't worth much. I think they should be firmly convinced themselves of what they want to teach but then I believe they should teach the facts at all levels. I don't underestimate the teen-age level by any means. I think they should have literature to read on various sides of the subject. We should present conservation and our views very strongly, but I believe you get furthest with them—I have just been through this with a teenager on a university problem—by presenting: "If you take this course, you do this; if you join a fraternity, you may flunk out of college; if you don't, you do this. You make your choice." I don't think we can afford, particularly at the university level, to say, "We are for the wilderness program. Go into your classes and plug it." I think what we should be doing is presenting the good parts of it, the bad parts—if there are any. I think there are some aspects that need scrutiny—who is going to use them, and so forth, and then let them make up their minds. I think we ought to face it that every professor at the end of a lecture probably gives his own views, but knowing students, I think quite often they take the opposite view from the professor unless he is very skilfull.

MR. TOWNE: Then you would not deny the professor his enthusiasm for the subject that he is teaching?

DR. BRAMBLE: That is right. We talked about this at the Extension meeting last night along the same lines. I don't think an Extension specialist would be worth anything in our state unless he was convinced that grazing in the woodlands was bad, but to go to a farmer and just say that, he can be offered all kinds of arguments. The farmer just gets his back up; he is stubborn and you don't get anywhere.

We have found, as I have indicated, that the best way to get at the farmer is to take his son, who is very pliable, give him the facts—and they are good facts—and he will go home and tell them to his father and his father will say, "Well, I've got a smart boy. Let's put a fence around that north border and keep those cattle out and fatten them out in the pasture where they should be."

MR. C. W. MATTISON [Forest Service; President, Conservation Education Association, Washington, D. C.]: I didn't get mad at the speaker and I hope I am not going to, but I sure am mad with a lot of people in this room. You know, one of the troubles of conservation education is that it costs money. It doesn't make any difference who is doing it; it costs a little money. I have been in New York since Friday morning. I gave a little talk at the Wildlife Federation on conservation on Saturday afternoon. I then played a little game ever since. I have been talking with people—I have talked to 25 or 30 specific people—and I have asked them if they want conservation education. They think we have got to have it. They are very enthusiastic. I agree with them wholeheartedly and then I mention the Conservation Education Association and say, "Would you like to help in this a little bit by becoming a member? It is only five dollars." Well, from that point on you would think I had smallpox.

Now, at Purdue University they have been in favor of this for a long time. In 1953 the University invited a few of us there and we formed the Conservation Education Association. That is made up not of professional conservationists altogether, but of men and women, lay people, educators, foresters and quite a lot of different people. There are around 400 members and you know darned well that is not many members. It is a mighty small organization and we are not doing much good, but if we could set some support from you people in this room we could do a lot more.

VICE CHAIRMAN CLEPPER: Have we got any other angry young men?

DR. HARRISON [Nova Scotia, Canada]: I am a young man but not an angry young man. I have laryngitis. I just refer to two points of terminology. One of the standard precepts in scientific nomenclature is that a name is a name only and has no necessary meaning, but I take it that the speaker whose address we have just enjoyed is not named "Bramble" for nothing.

The other matter which is perhaps worth a moment's time refers to a precept which didn't originate with me. It is very old but it is one that I think we ought not to forget and that is that a man can neither be praised nor insulted.

CHAIRMAN JOHNSON: Mr. Clepper and Dr. Bramble, I would like to raise a question. If it plagues us in general education I expect it plagues the general public even more. You referred to the fact that we have single-interest enthusiasts and, as you well know, we have plenty of single-interest enthusiasts on university faculties and I would like therefore to pose this question. You answered it in part but I would like to hear your further observations on it.

You referred to those in agricultural economics and their limited interest in this question. We can all witness on every campus in many cases the zoologists, the botanists, the foresters in some cases, the agronomists, those in political science, all of whom surely have some contribution to make. I therefore would like to raise the question with respect to education and the offering of courses, with respect to research on this question, with respect to service or extension, the question as to how we can better get organized, or better coordinate our efforts across these specialized lines in our universities even to give the kind of over-all, synthesizing point of view which these special-interest enthusiasts on our own campuses usually find it difficult to come by.

And to make it difficult, Dr. Bramble, may I suggest that I would be interested particularly in any observations you have as to how this can be done without us assuming that we have a Department of Conservation such as you have at Purdue.

DR. BRAMBLE: I think the reason why the agricultural economist is not convinced that forestry and conservation and woodland management and all those uses of the farm woodland are a good and should be an integral part of the farmers' program is because we have failed to get that across to them. The failure comes right back to us. This we are trying to remedy. It may take a few years. I don't know why we have neglected it.

I am not blaming the agricultural economist for his stand. I think we would have to get together with him—as a matter of fact what we have to do is to produce some real facts in the case to convince him and this we are about to do. We are getting at it very quickly.

In the conservation field they are apt to look at what they call the important things and out in our country you grow corn, you feed it to the hogs and you sell the hogs. If that doesn't work, why, you are broke. This is what the farmers are making their living on. If a man has a 200-acre farm he is not going to make his living out of 40 acres of woodland. The only thing we can hope to show is that this is an integral part of that farm and that he is making a good percentage return on his investment. We have found that the pride of the owner is a great thing there, in wildlife particularly. There is no inducement for a farmer in Fenton County to have ringnecks—that is, a good farmer. He is driving a Cadillac anyhow, the chances are, on that land, but we have some very good farmers who are producing wildlife. It is their pride. They have planted conifers. They have gotten good cover and they have ringnecks, and they are proud of the situation.

Now, on a campus I don't believe that by having meetings and just issuing instructions it will be done. It is going to take joint projects. This Rural Development Program is one way we are going to operate in Indiana to get this across. One of the economists recently discovered that people will pay for hunting; and they will pay for fishing in small ponds in southern Indiana. This can return income. So we have got to go into the Rural Development Program with them, go out in the field with them, attend their meetings and not just stand back. I think the program will go further ahead with our help than it is going now. That will get forestry, wildlife and agricultural economics together. I hate to see them going down the road alone. They make too many mistakes—they make too many misstatements. I believe it has to be a program that brings them together to work together and to research together and that is the only way that education ever will get ahead.

PROFESSOR WAGAR [State University of Colorado]: We have long known about your excellent Forestry School at Purdue; we also hear much about your Engineering School, but we in the West are very much concerned about the fact that no one can change natural life today as much as a civil engineer who knows little about what he is destroying. What do you do in your forestry conservation/engineering relationships at Purdue that the rest of us can copy?

DR. BRAMBLE: I wish I knew that. You know, the civil engineer that is coming up today is not the civil engineer we knew. They are not even taking surveying in many places. I know in committee we examine courses, and we objected the other day that we couldn't tell the engineering course from physics. They are the same. The engineering man said, "Well, we have taken over electricity and magnetism. That is engineering now." They are getting so far away I think we are going to have to bring them back to reality. How to do it I confess I don't know. You can't convince them that they need education in natural resources; and yet a civil engineer or a mechanical engineer or a chemical engineer may head a big pulp company. They do. We have to face it. They are usually very bright young men. I happened to meet recently with a chemical engineer who is an executive in West Virginia Pulp and Paper. He decides forestry practices and wildlife management—and I wish he had had some education in that. He is getting it now, the adult way.

I really don't know any way we can do that except to convince people in those curricula that their students need it, and this we haven't been able to do. As I say, it is a complete failure. The students across the campus in liberal arts or engineering, we have no contact with whatsoever.

Maybe someone else here has had the problem and has met it. I see a gentleman from Ohio State. What do you do there?

DR. DAMBACH [Ohio State University]: I believe the question Dr. Johnson raised, Dr. Bramble, has been spoken of in many of our large university schools across the country. As the universities grow in size they also grow in degree of specialization to a point where one specialty hardly knows what the other is doing.

In Ohio State University we found we had the same problem. We found that we had no less than five different colleges involving some ten different departments collectively teaching some twenty-five different courses dealing with natural resources in one way or another with professors teaching these courses not being aware of what the other was teaching, or even being aware of the fact that they existed. I daresay a similar situation probably exists on many other campuses across the country. So our university, as others, has stated the problem, "How do you get these people together?" Well, it just doesn't come about. You have got to have some kind of an organization, that is, somebody who takes as his responsibility the bringing of these people together; so—not because the academicians asked for it but because the trustees have been concerned with it—we have created on the campus what is called the Natural Resources Institute, with a person who has the responsibility not of directing but of coordinating and leading in the field of research and training in the fields of natural resources.

One way we attempt to handle this particular problem is to organize seminars, not only of graduate students but of faculty, and we have a regular faculty seminar in natural resources which meets roughly about once a month. Its purpose is that of presenting to the faculty current conservation problems of concern within the state and within the nation and trying to focus attention on their part on these problems and we have virtually every segment of the university involved in these seminars.

We do get the economists arguing with the biologists and the engineers and with the man from Medical School, and so on. Now, it is obvious they don't agree. We have yet to have a seminar where there was anything approaching agreement, but I am sure that each one goes back and argues among his colleagues, and this kind of thing goes on at luncheons at the Faculty Club, and so on.

I simply cite this as one of the mechanisms by which this terrific problem on the university campus can be approached. I am not sure of the final answer by any means but it is an approach in this direction.

CAN CONSERVATION BE SOLD AROUND THE WORLD?

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I didn't know when I was honored by an invitation to come here this afternoon that on the day before this meeting a large crowd of Bolivians would assemble in front of the American Embassy and the U. S. Information Service and do their best to destroy it, but it is as good a place to start as any on what I want to say this afternoon.

It does seem, doesn't it, that the brickbat throwers of the world are uniting against us? I have had occasion over the last couple of years, in connection with a survey we are making about the overseas Americans, to interview a good many Americans abroad, and their collective mood might be described by that remark that a man made to his psychiatrist when he was looking for a technical term. He said, "What do you call it, Doctor, when you think everybody is persecuting you—and they really are?" Well, we think everybody is persecuting us, and it does seem that they really are. Why is this?

It seems to me that the main reason is not because of numbers, although goodness knows there are plenty of Americans abroad—about one per cent of our population lives and works abroad—but rather because we are intervening in the internal affairs of about eighty other countries of the world. Of course, we keep saying we don't. We keep talking about the principle of non-interference in the internal affairs of other countries, but you and I know that this is—if the expression is permitted in a wildlife meeting—for the birds. The impact of our strength, the impact of the fact that we still produce close to 40 per cent of the world's gross product each year, is felt everywhere. I was struck in the last year with the observation that in country after country the hit song, the top of the Hit Parade was that old haunting, Oriental melody, "Rock Around the Clock," and the number two hit tune, incidentally, was that Pennsylvania Dutch melody "Throw Momma from the Train." I have been trying to find out from my friends in the field of sociology why this is, and they are evenly split, I am afraid. There seems to be one faction that believes that it is because this is a product of industrialization—you get railroads and this is the sort of thing that happens—and another faction that believes that this is simply the normal thing, industrialization or no, that you can expect in the way of an attitude towards mothers-in-law in a matriarchal society. In any case, the Hit Parade around the world is one evidence of the impact of the United States on the affairs of other people.

I had occasion to see another evidence in old Jerusalem about three years ago. I was walking up the Via Dolorosa, that narrow pathway, following the Fourteen Stations of the Cross, as every Christian tourist must, and I found myself wondering how it must have been 2000 years ago. Lost in these thoughts, it seemed to me that the noise, the smell, the confusion probably hadn't changed a great deal. Suddenly I looked up—and it was morning so I am afraid I didn't see the evening star, but I did see something even more impressive. I saw a big banner strung across between the buildings above me. "The Great Sioux Uprising," it said, "with Jeff Chandler."

And the news about Cyprus just recently reminds me of the comment of a friend of mine who claims a little guiltily that he is really responsible for all the trouble that the British have been having about independence on the Island of Cyprus. It seems that he was a young lieutenant j.g. during the Second World War. He found himself on the Island on the third day of July, 1944, with seventeen homesick enlisted men and he figured that something had to be done for the morale of the troops; so very early the next morning they repaired to the top of the nearby hill, and they shot off a few firecrackers. When they got through shooting off the firecrackers, which their mothers had sent them, they shot off a few rounds of ammunition and then they started on down the path to the village in which they were billeted. They were met on the path by a group of restless Cypriots, leaders of the village in which they were stationed, who wanted to know what had been going on up there on the hill.

"Well," the young lieutenant said, "there wasn't anything really. It was just a little celebration, that's all."

"Well, what were you celebrating?" one of the leaders asked.

"It was just our Fourth of July, one of our holidays."

"What is so special about the Fourth of July?"

"It is just our Independence Day, that is all."

There was a long and pregnant silence. The village leaders looked at each other and broad smiles crossed their faces. Finally one of them spoke up.

"Lieutenant," he said, "just who were you seeking your independence from?"

The ensuing silence was even longer. The young lieutenant shuffled his feet and looked up at the sky. Finally he said, "Look, fellows, it was a long, long time ago, but, as a matter of fact, it was—well—independence from the British."

"Independence from the British!" The leaders rushed on down to the village, alerted the entire community and the Americans, confined to their billets for the rest of the day, tried not to notice that the entire community was getting drunk celebrating *our* Fourth of July.

This is some measure of what we have done to the world with our ideas and with our techniques. I like to call it the triple revolution in the underdeveloped areas, the revolution of rising economic expectations, the revolution of rising resentment against inequality, and the revolution of a rising determination to be free and independent of ancient masters, if a little less clear about freedom from more modern masters. These deep desires are all, of course, the product of western example and western philosophy. The rationalism of Greece, the Christian ideal of the dignity of man, the self-confidence of Europe after the Renaissance, the American demonstration that equality and independence succeed, the objective success of the scientific methods of producing power and prosperity in our own nation and in the other industrial nations, all of these elements in our tradition seem to have conquered, converted the world. After uncounted centuries of ignorance and apathy, these ancient societies, of Asia and Africa particularly, want to participate in the good things that seem to result from these alien ideas.

More rapidly than seemed possible a generation ago the political claims have, of course, been made good. New nations with new leaders stand free of the antique structure of colonial rule throughout the so-called underdeveloped world. The days when progress was bought by shouting in the streets and sitting in colonial jails are pretty well through now. Now the rebels turned administrators face—and with desperate urgency—the unfulfilled expectations of their own followers for rapid economic progress.

There is a very popular calypso in West Africa at the present time in which the girl is singing about what kind of a husband she wants. She says that she has to have three requirements fulfilled. She wants to have a Jaguar, a "Fridge-full" and a "Been to." The Jaguar is not the kind you might expect to find in a South American jungle but the kind you might expect to find on the Thruway; the "Fridge-full" is a refrigerator full of food; but her husband must also have "been to" America or England or France for his education. He must be a returned student with the prestige of a western education.

So the age of economics, the age of arithmetic, is now upon us and it is dominated by a central idea, the idea of constant economic growth. This is a new idea, three hundred years old, I suppose, at the outside, violently contagious, shared now by all the western nations and spreading by the example of what a machine culture can produce for the people that control it. We Americans particularly have served as both experiment station and demonstration farm for an industrial society around the world.

We are involved in this affair whether we like it or not. We are involved because of our strength. You remember, I am sure, about the psychiatrist who said to the lady, "Lady, you don't have an inferiority complex. You are inferior." Well, we don't have a superiority complex. We are superior in certain rather impressive respects and we know what we know. One of the things we think we know something about is conservation. We know that there can only be enough resources for all of the people in any society if they are managed. This is the meaning of your whole meeting here. And so, for more than a dozen years now, on a very large scale and longer than that on a smaller scale, American conservationists have been selling conservation around the world on an unprecedented scale. They have been doing this with the same dedication and enthusiasm that has made the conservation movement so powerful in this country. There is no doubt we know our product, conservation, but how much have we learned about international salesmanship—let alone what I have learned this afternoon about the malaise you all feel about domestic salesmanship of conservation?

In my observation, at least on the international side, it is not enough. It is not nearly enough. Certainly we do have a great deal to offer the rest of the world in this as in many other fields. What we know about the use of water, the preservation and enrichment of soil, the protection of forests and grazing lands, the use of natural wilderness for recreation, the planning of urban growth—these lessons from our experience are exportable to the world even if we haven't learned how to apply them very well at home yet. But before our enthusiasm runs away with us, what about this matter of international salesmanship?

There are, I think, three principles which we should have learned by this time about the management of technical assistance to other countries. The first lesson is, as Paul Hoffman once expressed it, that technical assistance cannot be exported; it can only be imported. We know this from our own extension experience in this country. You can't ever sell a farmer anything; he has to buy it, whether it is a thing or an idea. This is indeed the first principle of international relations in general. The experts call it cultural empathy, which is to say, the skill to understand the other fellow's way of thinking plus the restraint not to judge it as bad just because it happens to be different from our way.

I was very much struck a couple of years ago to observe in Tokyo that the Japanese have a different way of numbering the houses on their streets to the way we number them. We have, we think, quite a logical system. We start at one end with the lowest number and we wind up at the other end with the highest number. Of course, we obscure the numbers, so we can't find the houses very easily, but beneath the ivy and behind the trees we do have a system. We have a system that has a kind of inner logic and coherence. The Japanese have a different system. When they number their houses on their streets at all, which seems to be infrequently, they tend to make the oldest house the lowest number and the newest house the highest number. You see, this has a certain logic to it, too, though it is equally hard to find the house. But since they don't find the houses by looking for the numbers anyway, it doesn't seem to matter to them. They find the houses in cities the way we find a house in a rural area. It wouldn't occur to you in a rural area to ask what number a house was. You would say, "Well, you go down a couple of miles here and you come to a dirt road and you go left and there is an aluminum barn and you go right and then it is the third house on the right, a great big white one." This doesn't seem to us a particularly exotic way of describing how to get to a place in a rural area. They just apply it to the cities.

The skill to understand the other fellow's way of thinking and the restraint not to judge it as bad just because it is different from our way: my own favorite way of thinking about this is the story that John Coast, the man who brought the Bali dancers to this country, brought back with him. It was about an argument between an old Malay and a British colonial administrator named Sir Hugh Clifford about whether you should eat with your hands or whether you should eat with knives and forks and spoons. The old Malay finally produced what seems to me to be the clinching argument. He said, "Sir Hugh, what you don't understand is this: I am sure that my finger have not been in anybody else's mouth, but I am not so sure about your spoons." For a moment, you see, you just have to look at it from his point of view. How does this apply in our situation here?

It applies because the case for using natural resources efficiently is essentially different abroad from what it is here at home, the case for conservation. The driving force behind this Institute really doesn't have very much to do with starvation and unemployment. Indeed your work is the most dramatic possible demonstration that we have achieved enough freedom from want to begin worrying about how our countryside is going to look in the future, about whether there will be any space left over from agriculture and what one Congressman calls "urbiculture" for those of us who like to get outdoors once in a while. But abroad the case for conservation is more elemental. With population growing at breakneck speed—one billion in the last fifty-nine or sixty years—conservation is the law of life for countries which may or may not have enough food for the growing number of mouths.

The first principle of international salesmanship, then, is the adaptation of our thinking to the felt needs of our friends abroad, starting where they are, not where we think they ought to be. Adapt, not adopt, can be our slogan. Or, as a Brazilian recently put it to one of our interviewers, "To teach us baseball you must first learn to play our kind of football."

The second principle of international salesmanship that I would suggest to you is that we must finally organize for the task of technical assistance in a sensible fashion. I am very glad that the Chairman mentioned the narrow specialization that is so familiar a characteristic of this country because it really leads to what I want to say on this point. As things now stand, the struggling governments of the underdeveloped nations must deal with from 16 to 22 different American and U.N. agencies, all of them selling some special brand of technical assistance, all of them independent and jealously conscious of their own sovereignty, all of them touching on the conservation of resources in some specialized way. We who are interested in conservation have been—let's face it—among the worst offenders in this. If we are worried about forests, we set up a worldwide forestry program. If we are interested in fish, we establish a global fisheries crusade. The same goes for each disappearing species of wildlife. In just the same way the public health people get excited about killing anopheles mosquitoes all over the world; and the highway engineers enthuse about building roads all over the world; and the financial experts, who in some ways are the worst of all, create a new global bank every time they think up a new kind of soft loan to offer to an investment-hungry world.

But we really know better than this from our own experience. Surely we are intelligent enough to discern that the world is not organized by mosquitoes, soft loans, fish, forests, and so forth. The world is organized for better or worse, by countries and regions. Here at home we have learned from bitter experience that in a river valley or metropolitan area the area must be considered as a whole, that agriculture, forests, water resources, recreation facilities, health and sanitation conditions, transportation arteries and investment capital must all be related to each other in some rational way that takes into account the whole of our scientific knowledge in all of these fields. Only thus, we find, can the needs of the people in the valley or the metropolis be served. And the same is true abroad.

It is, indeed, much more true abroad. In most of the world the newly developing nations cannot effectively handle the task of coordinating all of our American and United Nations agencies that crowd in on them independently; nor can they afford the waste that comes from the presence in their countries of dozens of "experts" from the West, each riding his own favorite hobby horse. No wonder we are sending abroad, to Asia, Africa and Latin America, increasing numbers of public administration experts to help these governments do the coordinating job that we have neglected to do ourselves.

Conservationists surely should be the leaders in making sure that in our overseas programs we apply not only what we have learned from our scientists but what we know from our own experience in the regional management of natural resources. If you don't take the lead in this, who will?

The third problem about our international salesmanship that I would mention is this word that you use, and that I use, too, "conservation." We live in an era of very rapid change. Charles Frankel, a philosopher at Columbia, a little while ago had a piece in ***The New York Times Magazine*** in which he put this in a rather arresting way. He said, "In the whole history of mankind it took us 475,000 years to get to the agricultural revolution; and then it took us 25,000 years to get to the industrial revolution; and then it took us 150 years to get to the space age; and" he said, "we don't know where we are going next but we can be sure of one thing, we are going there fast."

Well, now, most of the rest of the world believes this, whether we believe it or not. Most of the rest of the world knows that a government that is *in* is by definition on its way out. Most of the rest of the world knows—although we don't seem to reflect this knowledge yet in our diplomacy—that it is much more important to get along with the *next* government than with the present government in many societies, that an assumption of change must be built ino our foreign policy, our technical assistance program and indeed the whole of our educational process.

In this picture what is the impact abroad of the word "conservation"? It is an impact of conservatism, it is an impact of "the status quo mentality of those Americans," as I have heard it described, it is the impact of a self-satisfied nation. It sounds as though what we really want is to keep on being the richest nation in the world—to conserve what we already have.

I suggest to you in your international aspects—and every profession now has its international aspects, conservationists more than most others—that this word "conservation" translates badly. In most foreign languages it translates into a status quo kind of word. Maybe one of your sessions one of these years ought to be devoted to trying to think up a more dynamic word. It *is* a dynamic word to us who are familiar with it and who have grown up with it. "Conservation" to us is a kind of crusading word, but it doesn't have this crusading character abroad, I can assure you.

In this era in which we are the butt of many brickbats, in this era of reciprocal intervention and the mutual interpenetration of whole societies, we have a particular problem, we Americans, which is our power. It involves us in every change all over the world and it embarrasses us, too; we are embarrassed at the rate of change that we are helping to bring about with our science and our technology and our ideas about large-scale organization. It is a difficult role for us, because we Americans rather like to be loved, and I think we are probably going to have to learn the fundamental lesson of power, which is that it does not readily hold hands with popularity with love.

In Calcutta they tell a story about a rich Bengali, who was informed that a friend of his really hated him. He thought for a moment and he finally said, "I don't understand why that man should hate me. I have never helped him in my life." Well, we are not so fortunate. As the Foreign Minister of Indonesia told us in one of our interviews, "More is expected of the Americans because of their power. People will expect the Americans to make a great effort to understand them without making themselves any great effort to understand the Americans. But," he shrugged with a kind of philosophical smile, "you Americans shouldn't worry about it too much. This is the price of power."

As we live these days among the brickbats, perhaps the American version of that advice, in the American idiom, is the remark, the unconscious wisdom of a veteran marine pilot who was taking a young co-pilot on his very first sortie over enemy territory during the Korean war. The young fellow was very proud of himself. This was his first enemy engagement. He looked down at the rugged greens and browns of the North Korean countryside, looked around at the perfect blue sky, noted with a certain aesthetic pleasure the little puffs of white smoke appearing in the sky around the plane. Suddenly he realized that this was real anti-aircraft fire, real for the first time. He grabbed in panic for the intercom. "Hey, Joe," he said, "they're shooting at us."

The calm, wise, tired voice of the veteran Joe came back over the machine, "It's all right, son. They're allowed to."

DISCUSSION

MR. ROLAND COBB [Maine]: I am expressing a little concern. I have heard the last two speakers mention—one describing the misinterpretation of the use of the word ''conservation.'' I don't think that is limited to areas abroad. We don't even know in our own country what conservation means. I am very much concerned and I will just give you an example, Mr. Chairman.

In the State of Maine we have a Federal forest and we have excellent relationships between our biologists in our Department and the Federal Forest group. We have a Fish and Wildlife Reservation. We have a good so-called partnership relation. We work very closely and very happily with them. Now we are facing in Congress a Wilderness Bill which we are all asked to support, and which I am very much for as the Wilderness Bill is concerned. If the administration of the Wilderness Bill comes under the National Park Service I am not interested.

We have to the east of us Mount Desert Island, which is a Federal park. We are not welcome. There has been made no opportunity—although we have tried—to cooperate in a partnership relation with National Parks. There has been discussion in the country, in Maine, of the National Parks. I shall oppose it as long as the National Park Service attitude is ''No partnership relation with states. When we take it we will do just what we please with it and to heck with everybody else.'' Maybe I am indicting them too strongly, but I am asking the question of you gentlemen—originally I wanted to ask it from Dr. Bramble because I think it is a matter of conservation education. We haven't educated our own agencies within state government. Here is an agency—and Under Secretary Seaton and the Fish and Wildlife Service are most cooperative; there is a fine partnership relation—here is the Federal Park Srvice, under the same head, that has no apparent desire that we can determine to give any cooperation or permit any cooperation from the state.

The major concern is how far has it gone with conservation education? It is my belief that the National Park Service doesn't even know what the word ''conservation'' means in the sense that we and Fish and Wildlife are taking about. If Dr. Bramble can answer that question I will be very pleased.

DR. BRAMBLE: We had a very interesting study recently. It opened our eyes. We studied the National Parks, a certain select group of them, through questioning which the National Park Service permitted us to do, to try to find out what their objectives were. It was very interesting. A number of men working in the Park Service seem to use the word ''preservation'' but we found, strangely enough, they were actually practicing conservation. They are really carrying out a wide use so far as we were concerned. Their best use was recreation while preserving natural scenic values. That is a thing we got back on time and time again. Their use was designed so it wouldn't wreck their scenic values or recreation but the men themselves didn't use the same word. We found, just briefly, that the Park Service was practicing conservation without being completely aware of it. I think they are on the right track.

I don't know about their cooperation.

VICE CHAIRMAN CLEPPER: Rather than take the time of the audience to discuss an issue that may be somewhat controversial about the intent of Federal agencies, Mr. Cobb, there are several people sitting within twenty feet of you who are extremely familiar with the policies of the National Park Service and I would like to suggest that one, at least, of those gentlemen discuss this with you before we retire.

MR. FRED PACKARD: I am Fred Packard, formerly of the National Parks Association, now working with the International Union for Conservation.

I simply want to comment that if any of you are particularly interested in actively cooperating and participating in international activities in the fields in which we are all concerned, there is an excellent and very active and very vigorous international organization in which your organization has membership and that is the International Union for Conservation which has its headquarters in Brussels. Its full title is International Union for the Protection of Nature and Natural Resources.

The international activities during the past ten years have extended tremendously, partly through the influence of the International Union, which was founded ten years ago. They hold international conferences and general assemblies throughout the world every two years and sometimes hold their conferences every other year. The membership is open to organizations which are concerned with these conservation problems, particularly in the field of the preservation aspects of conservation, but also any other.

They work for the United Nations organizations and with many governments throughout the world. They have had an amazingly successful record of interceding with governments and to assist governments to do the right thing and to avoid making mistakes in many fields of conservation and I urge the International Union to your attention.

The speaker on international affairs made one point which was very relevant to my experience in this field and that is the point that we must adapt our programs to theirs rather than expect them to adopt ours. That is very true. I had the privilege a few months ago, after attending the International Union's Assembly at Athens, to be invited by the Turkish Government to advise them on some national parks that they wanted to establish in Turkey and, interestingly, the proposal for national parks in Turkey has come from the Turkish Forest Service, which is one of the most advanced forest services I have ever been in contact with. I found that the most beneficial thing I could do over there was simply to pick up the recommendations being made by their voices crying in the wilderness, the people in their own country who are aware of the need not only for a national park service but for conservation programs, and repeat to a great extent their own ideas to the officials who were in charge of the administration of resources. I was told on many sides that it was very helpful to them to have someone from another country come to their country and advise them and say the same things they are saying. As a prophet is without honor in his own country, a prophet from another country is often with great honor in that same country and the point was very well made. There is a great deal that we can do in America and from America if we will work with these other countries in helping them to promote their own programs and I invite your attention to the International Union as a focal point through which some activity can be undertaken. Thank you.

MR. CLAYTON HOFF [Wilmington, Delaware]: I would like to comment both on Dr. Cleveland's statements and on Dr. Bramble's statements. It was mentioned, I believe, by Dr. Cleveland that part of our difficulties in other countries rests with the fact that we have a multiplicity of experts each working independently. It was indicated that the same thing has greatly handicapped the progress of the application of conservation practices and the conservation of our natural resources here, that we have not coordinated the work of many experts. It has also been indicated that in our universities we might start that coordination between the different experts by teaching and getting each expert—the experts in the different fields—well acquainted with the others.

That has been applied in a good many universities in the conservation courses where an attempt has been made to coordinate the various fields and yet that results in quite a few difficulties. Where can a graduate who has really qualified as a conservationist, developing a broad knowledge in all fields, find employment? Until we have the various branches of our state governments administering our state resources, until we have the various branches of our Federal Government, changing their requirements, the requirements for employment, changing the several service requirements, until they do not require entirely a specialist in each field, I think we are going to be confronted with that problem of coordination of our various experts in our field of the natural resources conservation here in our own country.

I submit that that has been overcome in some cases by the application of the conservation of natural resources through the watershed principle. I have had occasion to interview a good many graduates from the conservation courses. I have talked to men who have had experience in the broad fields of all conservation on watershed work and their answer invariably is, "Where do I go from here? Where in our Federal Government or state governments can a man with broad training in all natural resources find an application for his knowledge?" Therein, I think, lies a weakness and I would like very much to have Dr. Bramble comment on that.

DR. BRAMBLE: That is a very difficult thing to answer directly. I think the various agencies, let us face it, do need for their specific jobs men that are trained in their specialties. I think they have to have them. I don't think a man could handle a continuous forest inventory or one of those similar set-ups unless he is trained in mathematics and statistics and the background of that work, but I do believe they need a broad man up at the top. This is a problem. We faced this, I believe, at the Conservation Conference, that industry, if they are looking for a top man, do not take a man that has just graduated from college with a broad training. He hasn't had the experience. And this is generally true. I think they need a man in their organization to coordinate these and this is where the broad conservation man would come in, to bring the specialists together. I do agree. I think there ought to be some bracket there where these men can go in and go up through a training program. At the present time this really doesn't exist and industries themselves just tell us they aren't interested in these men. They would rather take a specialist, an engineer, and make him a planner for their new plant locations and that sort of thing than take a young man who has just been broadly educated in a university. I can't say I blame them too much because a boy who has only been through four years of university training, broadly trained, still isn't ready to accept the job of a coordinator. There should be some way, however, of giving him enough experience for enough years after that training so that it can be used. At the present time I think, Mr. Hoff, that you are right, that even the Soil Conservation Service can't accept these boys because of their Civil Service regulations.

DEAN CLEVELAND: May I comment on that?

I think there are a couple of lines of approach to this that would tackle it from the other end. Our School makes quite a specialty of training for the public service including a rather strong graduate program in public administration and we have introduced into that program in public administration a course, taught by one of our top professors, who is a political scientist but who has done a good deal of work in regional planning and regional resource management as a practitioner, we have introduced a course in natural resources in which we try to bring in a number of the different specialties, not to make them specialists in forest management or whatever, but to give them some idea of what these people are talking about.

These are people who will go into the public service who will tend, because of the way the bureaucracy is set up, to be among those who gravitate to the top because it is the fellow that understands how to get along in a large organization that tends to rise to the top. We find now that some of the graduates of this program, over the last few years, are tending to get into state government situations and city situations and to some extent into Interior and Agriculture in the Federal Government, in positions where perhaps ten years from now they will be coordinating the specialists in the field of conservation. One way of operating, therefore, is to make sure that the administrators, who seem to be inheriting the earth, get a good dose of conservation before they get too wrapped up in the bureaucracy.

The other approach, I think, is the much maligned adult education approach. It does seem to be characteristic of our society that the way you get ahead for the first ten, fifteen, even twenty, years is to be a really effective specialist but that people then pass a certain invisible line, a good many of them, and find themselves having to operate as if they were generalists, whether they themselves have the capacity for a generalist approach or not. I think that one of the big developments in adult education in the next few years will probably be an attempt to expose the specialists who seem to have a yen for this coordinating function to that specialty which after all also has quite a lot of lore connected with it, the specialty of administration, the expertness in how to pull a lot of experts together and make something happen.

MR. LONG: I am from the Finger Lakes country of western New York. Most of the organizations that I attend are fish and game club meetings, so-called sportsmen's organizations. Many of the members of those organizations have gone only through high school so that the education which we have heard discussed today beginning at the pre-college level, if it hit them at all glanced off harmlessly. There are certain characteristics of the members of these clubs which they have in common. Most of them are local and all of them have votes. We from time to time have to get bills through our State Legislature for the benefit of what we think is best in conservation and the difficulty of getting votes is that many times the people who are going to pass that vote are grossly ignorant. Their emotions have been fed by newspaper columnists and so forth and I think that a field of education which has got to be taken care of at their level. We ourselves are buying many of Dr. Eschmeyer's books and putting them in the primary departments of schools and they are being read and I think are doing a lot of good. How you are going to go about it I don't know but, God knows we need it.

DR. HAROLD COOLIDGE [Washington]: I was inspired by what Dean Cleveland had to say in connection with the problem of selling conservation round the world and I think that in the wildlife field there is a very neglected area in trying to sell conservation around the world. In our ICCA missions which are in so many foreign countries, you will look in vain for any wildlife specialist to assist in the work of those missions, with the excption of the field of fisheries. In many countries which I have visited one of the groups of specialists that they would like most to have come from this country are experts in wildlife management to help them with their wildlife problems and in Africa the wildlife problem is, as you all know, an extremely serious one at the present time. We are endeavoring to help with that by sending numbers of Fulbright scholars, specialists in this field, but it is far more appropriate that in our ICCA government aid programs we should recognize the need of supplying wildlife experts.

We are exporting a lot of engineering know-how. In some countries they are building dams in national parks and these are being built by American engineers who are coming from this country and doing some of the kinds of things that we don't want done in this country but there is no opposition to their being done in other countries. I think this whole subject of conservation around the world is one that we should give a great deal of thought to and we should make more of our specialists available and train more people to do a competent job.

MR. PREVOST [Montreal, Province of Quebec, Canada]: I heard a lot about conservation education. I think that our people need good conservation education. We require a biologist in all of our companies. When we started work we had hatchery managers in all of our companies but now in Quebec we have fortunately aquatic biologists in charge of the hatcheries. We think we have the same problem with the engineers, especially the health engineers. I have good friends among them but I don't think that with the ideas of biology that they have after five years of civil engineering that they can direct pollution work and I don't think—in the States as in Canada—that we have enough aquatic biologists on the boards of the engineers and on water pollution commissions. Most of the time the biologist, the aquatic biologist, is just at the end of the table, he has not got much power, so I think if we can use, by those conservation groups that you have here in the States and that we have in Canada—they have helped us a lot by requests for more biologists on all those boards and I think it is very important. It is no use to go and tell the people that we should take care of our rivers if our engineers are the first to neglect them. Thank you.

CHAIRMAN JOHNSON: The comment made by the second speaker from the last leaves me in some quandary about the effect we have had in this program on you. It reminds me of the gentleman who said he had gone to a meeting quite confused but when he had come out of it he at least was confused at a much higher level. [Laughter] We hope we haven't had that effect here and we are sure that all of these people are very much concerned about doing something significant about this question and all these questions at all of the necessary levels, including the international, to which we have also addressed ourselves.

In closing it occurs to me that we have quite naturally spent most of our time talking about methods in dealing with these billion dollar questions, methods which are educational, informational and we might say non-coercive. It occurs to me, therefore, that in a sense, underlying all of these billion dollar questions you have another billion dollar question, not actually in the sense of value but in the sense of the difficulty of answering the billion dollar question of how you strike the necessary balance between the non-coercive and the regulatory and the private and the public, which is necessary to provide solutions to these very difficult issues of national and international life.

GENERAL SESSIONS

Wednesday Afternoon — March 4

Chairman: Roger D. Hale
Vice President, The Conservation Foundation, New York City, New York

Vice Chairman: William H. Meyer
United States Representative; Former Executive Director, Vermont Forest and Farmland Foundation, Incorporated, West Rupert, Vermont

URBAN, RURAL AND WILD LAND PLANNING FOR A BETTER AMERICA

MEETING FUTURE RECREATIONAL NEEDS

Laurance S. Rockefeller

Vice President, The Conservation Foundation, New York City, New York
Chairman, Outdoor Recreation Resources Review Commission, New York City, New York

It is a great pleasure for me to be here today. In a sense, this is my first public appearance as Chairman of the National Outdoor Recreation Resources Review Commission. Naturally, I would prefer to talk about the accomplishments of the Commission rather than its plans. However, as our work is just beginning, I can of course only speak of the plans. I am delighted to have the opportunity to do so before this conference, whose members have long shown their deep interest in the subject of the Commission's study.

I might note that in one of the earliest meetings of the Commission it was agreed that where questions of opinion were expressed by Commission members in public, we would speak only as individuals in order to maintain the objectivity of the Commission. Thus, I have divided this talk into two parts: In the first part—where I try to spell out the why, what, where, when and who of the Commission—I shall speak as its chairman; when I go into what I believe is the underlying philosophy that must guide our thinking, I will be speaking simply as an individual interested in our nation's recreational resources.

The title "Meeting Future Recreational Needs" is both broad and ambitious, but no more so than the task set up by the 85th Congress last year when it established the National Outdoor Recreation Resources Review Commission.

The *why* of this accounting lies in the fact that in creating the Commission, the Congress and the President recognized that conservation for the physical, cultural and spiritual benefit of the American people is in a critical period of transition as a result of new demands. The unprecedented growth of population, the basic shifts of age groups within the population, the increase in leisure time because of shorter hours and earlier retirement, increasing urbanization, and the tremendous strides taken in transportation all lead to the need for re-examination of our outdoor resources and a new appraisal of our requirements, not for just today but, in the terms set out by the Act establishing the Commission, looking as far ahead as the year 2000.

The *what* of the Commission is pretty plainly set forth in the establishing act by Congress. Our task will be, in the words of the act:

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

(b) "To inventory and evaluate the outdoor recreation resources and opportunities of the Nation, to determine the types and location of such resources and opportunities which will be required by present and future generations.

(c) "To make comprehensive information and recommendations leading to these goals available to the President, the Congress, and the individual States and Territories."

Now as to the *where* of the Commission's work. In the first place, possibly we should define what is meant by outdoor recreation resources, and for an accurate account I shall use the formal definition set out in the act:

> "Outdoor recreation resources shall mean the land and water areas and associated resources of such areas in the United States, its Territories, and possessions which provide or may in the future provide opportunities for outdoor recreation, irrespective of ownership.
>
> "Outdoor recreation resources shall not mean nor include

recreation facilities, programs, and opportunities usually associated with urban development, such as playgrounds, stadia, golf courses, city parks, and zoos.''

The Commission's evaluations and recommendations are to be made on a state-by-state, region-by-region, and national basis. Needless to say, local and community relationships must play an important role if the Commission's objectives are to be achieved. As part of its work, the Commission must survey, analyze and catalogue all presently existing outdoor recreation areas and, in doing so, the Commission will keep in mind both present and potential use. The scope of the Commission's operations will require it to determine the qualitative as well as the quantitative recreation facility needs of the American people. Naturally, there has to be some general relationship between the amount of land assigned to specific recreational purposes and the popularity of the purposes involved, but this cannot be formulated on purely mathematical terms; for recreation facilities and the need for them bear a direct relationship to public health and other social considerations as well as to population growth and concentration. In summation, the Commission's *where* covers the entire nation, for means must be found to survey the nation and pinpoint available sites, irrespective of ownership or present use, which might be used for recreation purposes, and which can be added to those already partially or fully developed, for the purpose of more nearly matching availability of nearby recreation areas to recreation needs. Special attention will be given to new multiple uses where this is judged compatible with presently established uses.

Only in this way can a formula be worked out in which we can make recommendations, where indicated to the Federal Government, states, counties, municipalities, and private owners for the creation, management and financing of present and planned recreation areas.

We come now to the fourth ''W'' or the *when* of the Commission. By September 1, 1961, the Commission is asked to present a report of its review, a compilation of its data and its recommendations to the President and Congress. Act S.846 calls for the National Outdoor Recreation Resources Review Commission to cease to exist not later than one year thereafter.

The present plan of the Commission is to allocate its three-year term roughly as follows: (a) The first year to be devoted to an over-all staff study and correlation of all available materials; (b) the second year to developing conclusions, policy and program; (c) the third year to completing the report and making recommendations. One quite obvious difficulty facing a new Commission such as ours is the always adherent and ever-present desire by interested parties for it to arrive at conclusions before an objective study has been made. No doubt a great many special interests will in all honesty expect the Commission to take positive stands either for or against pending legislation, or in connection with areas where use and protection may be in conflict.

With regard to other legislation which might effect recreational areas and opportunities, it is the majority opinion of the Commission that no recommendations should be made by it unless specifically requested by the Congress or the President. And it might be added it is our earnest hope that such recommendations will not be required before the review is far enough along to be significant.

We now come to the *who* of the Commission. As you may know, the members of the Commission have a responsibility under the Act to coordinate its objectives with various persons and activities. We have spent already a considerable amount of time building what I consider to be this very essential base from which to operate.

The Commission, of which I am privileged to be Chairman, has fifteen members. Our congressional contingent has four members of the U. S. Senate—Clinton P. Anderson, Richard L. Neuberger, Henry C. Dworshak and Thomas E. Martin—and four members of the House of Representatives—Harold R. Collier, Gracie Pfost, John Saylor and Al Ullman.

The other members of the Commission, in addition to me, are: Mrs. Halfdan Lee, Samuel T. Dana, Bernard Orell, Joseph W. Penfold, M. Frederik Smith, and Chester S. Wilson.

I believe most of you are already acquainted with these people, who have been long identified with the broad areas with which we are concerned.

The Act calls also for the appointment of an Advisory Council of twenty-five, who represent various special interests and geographic locations. To make sure that we would get the ablest and most representative group available, we requested recommendations for nominees from approximately 200 organizations and citizen interest groups. We have received to date over 500 nominations and have reviewed each with regard to respective categories of interest, abilities, etc. We will shortly announce the names of those appointed to the Advisory Council, which, we feel, will be a very important arm of this Commission. I might note that uppermost in our minds in selecting this group has been our desire to get persons to participate actively on the basis of a broad understanding of the underlying problems rather than merely representing special interests.

Mr. Francis Sargent, former Commissioner of Natural Resources for the Commonwealth of Massachusetts, officially started his tour of duty as Executive Director to the Commission just three days ago. In various positions, he has served under both Republican and Democratic governments in Massachusetts. He has been Director of Marine Fisheries, Chairman of Atlantic States Marine Fisheries Commission, one of the three United States Commissioners on the International Commission for the Northwest Atlantic Fisheries, and Chairman of the Massachusetts Water Resources Commission.

That we were lucky to get Mr. Sargent as Executive Director is attested to by the really tremendous number of laudatory articles and editorials which appeared in the newspapers of Massachusetts since his resignation from his posts there.

A small but very capable staff is already at work at our headquarters in the Regional General Services Administration Building, Washington, D. C.

We have been in touch with each of the thirteen Federal departments and independent agencies having a direct interest in outdoor recreation and have requested the appointment of liaison officers from each. In every case, an Under Secretary, Assistant Secretary or a Director has been named to work with the Commission. I personally have had the opportunity to meet with most of the Secretaries and Agency Heads in regard to their designation of a liaison officer and have found them unfailingly cooperative and actively interested in the job we are undertaking.

In the course of the Commission's life we will wish to coordinate our work closely with that being carried out by individual states. Indeed, we plan to take into account the problems and opportunities of outdoor recreation in each state. This, of course, will require access to such studies by the states as might be available concerning existing and possible future recreational problems as well as plans for meeting them. To further this program, we have written to the Governor of each state requesting the designation of an official with whom the Commission can work.

In addition, we will call on individual consultants and private consulting firms to the extent that they can enable us to get specific information as needed without having to enlarge our staff.

We are hopeful that the type of joint effort we will endeavor to carry out at all levels of government—be they state, federal, county or municipal—and with private persons and groups, can provide a lasting service to all concerned with the broad problems of recreational resources.

Before concluding, I should like to add a few personal observations about the underlying importance of outdoor recreation resources.

Quite apart from the physical benefits resulting from outdoor activity, man needs outdoor recreation resources because it is through them that he is reminded that he is part of nature. There was a time, not too long ago, when such reminders were not needed. Outdoors, natural beauty—and natural hazards—were a part of everyday life. Indeed, I fancy that there were a great many people, especially among the early settlers, who then looked upon nature as a constantly threatening force, ever to be pushed back. In this connection, many people today feel that the hardy pioneers of yesterday were impelled to seek new horizons not by a love of the wilderness as by a desire to improve their condition or status.

When the pioneers had no new lands to conquer, when people started moving from isolated farms to small communities and thence to urban centers, our relationship with nature underwent great change. As we became less fearful of the forces of nature and more mindful of the pressures of civilization, we began to seek solace in our former foe. Thus the need for outdoor recreation resources became established. Recognition of this need has tended to grow proportionately to the increasing urbanization of our country.

The United States, despite having been a forerunner in the establishment of national and state park systems, is on the whole just beginning to wake up to the vital importance of recreation. The reasons for this are not difficult to ascertain: we are still a relatively new country and have been engaged in the necessity of settling and developing a land that was wilderness two centuries ago. Thanks to the energy and drive of our people as well as to the wealth of our natural resources, no nation in history has developed so fast. But to accomplish this, our society in the past has had to emphasize—and rightly so—the dignity of work. Recreation, or the proper use of leisure time, has not yet attained a comparable social or moral stature. It is still considered by many, including policy makers, with suspicion—as a waste of time.

We can recognize, as a sign of our reaching maturity as a people, that this attitude is beginning to change. We are beginning to recognize that outdoor recreation—as a healthy, satisfying and often creative use of leisure time—has evolved from a luxury of the few to a necessity of the many. We must recognize also that sports promotion, travel advertising, and the commercial use of outdoor areas and attractions have all played a part in accentuating the demand for outdoor facilities.

To meet these demands, I think they must be approached on three fronts: Federal, state and community. Great strides have already been made but I feel much remains to be done—particularly in the third area. Recreational problems at the community level are particularly important because there are fewer answers and greater pressures. An editorial in the *New York Times* last week mentioned in this connection:

> "Our city and our suburbs need more park land, not less. . . . There would be a willing buyer, industrial, commercial or residential, for every piece of park land in the metropolitan area if government were willing to sell out. Our suburbs are for the most part poor in public recreation areas. They cannot spare an acre."

While this editorial was referring to the situation in New York, it could apply to most of our large cities throughout the United States.

I have previously spelled out the official *why, what, where, when* and *who* of the Commission. Unofficially, I would like to recapitulate as follows:

The Commission expects to serve as a clearing house of information and ideas.

Its review will cut across all areas and all activities dealing with land use.

Its purpose is to anticipate needs and prevent shortages in our natural recreation resources.

Its work is already in progress; its findings will be made available in 1961; its responsibilities are to tomorrow as well as today.

The Commission recognizes that outdoor recreation resources are something in which every one of us has a stake.

The goal of the Commission will be to reflect the needs and aspirations of the entire national community.

DISCUSSION

VICE CHAIRMAN MEYER: Thank you, Mr. Rockefeller, for a very good paper. There was a time when the word "planning" was almost a dirty word but I am sure that with the impact of the changing America and the pressures upon our resources we know that we need some planning.

CHAIRMAN HALE: Thank you, Mr. Rockefeller.

It is good to know that planning our future recreational needs is in such good hands, and for the first time we will probably have a truly basic study of what we need in this very important field. I think it is also important that all of us here who represent various organizations that are interested in one form or another of conservation . . . recreation, give Mr. Rockefeller's Commission every cooperation and help that we may be able to while he is working with this over the next couple of years.

METROPOLITAN SPRAWL

MELVIN E. SCHEIDT[1]

Consultant and former Director, Baltimore Regional Planning Council, Baltimore, Maryland

Some fifteen years ago a writer friend of mine, seeking the peace and quiet of the open spaces, but wanting to be within commuting distance of the metropolis, built a home in the desert east of Albuquerque, New Mexico. Today he is surrounded by a closely built up suburban community stretching still another several miles into the desert. His experience is typical of thousands of people in the 180 metropolitan areas of the United States.

In 1930 the City of Baltimore contained 804,000 people, but the four surrounding counties totaled only 228,000. By 1957 the city's population had only increased to 980,000 people but the surrounding counties had grown to 727,000 people. Of even greater significance are predictions regarding future growth. By 1980 the regional population is expected to reach 2,600,000 and may reach 4,000,000 by the year 2000. However, the population of the city proper is only expected to reach 1,200,000 by 1980 and probably will never have more than about 1,300,000 at its ultimate density.

What is happening in Albuquerque and Baltimore are merely two examples of the explosive outward expansion that is taking place not only in most of the metropolitan areas of the United States but in most such areas of the world where our western economic and social culture prevails. This expansion stems from three principal causes.

First, of course, we must recognize the startling increase in the birth rate over the last two decades. Whether this is a permanent trend is the subject of much debate, but certainly the marked improvement in living standards for all levels of our society, resulting from the practical application of scientific discoveries, medical developments, and increased production has been a strong influence. But whatever the cause, national population has increased from 123 million in 1930 to 173 million in 1958 and predictions are made that there will be 62 million more people in the United States by 1975 and a total population of perhaps 300,000,000 or more by the year 2000.

The second major influence on metropolitan growth is the fact that we have become essentially an urban nation, and will become more so with each passing decade. Farming, which used to be our

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national way of life and still exerts a strong influence on much of our thinking, is rapidly becoming an integral part of our industrial system. Advances in agricultural research and technology have made possible the production of increasing quantities of food and fiber on the same acreage, and modern farm machinery now enables the individual farmer to manage four or five times as much land as he did a generation ago. Consequently, the number of farmers has actually decreased in the face of increasing population. The majority of our population now lives in or near urban centers. Furthermore, most of the shift in population is to the larger metropolitan centers. Small towns appear not to be growing and some are actually decreasing.

The third and perhaps the most significant factor affecting metropolitan growth is the private automobile. Prior to the automobile, cities did not sprawl as they do today. Cities grew, of course, and suburban development did exist, mostly along rail lines leading to town, but in many respects the city was otherwise neatly contained within boundaries which clearly marked the transition from urban to rural life. With the advent of the automobile, this situation changed vastly. Today, it is difficult at times to decide where urban areas end and rural regions begin. Although rail commuter service has virtually ceased in many cities, people now think nothing of living 25, 30 or even 40 miles in any direction from their places of business and driving daily by private vehicle to and from work. The automobile also makes it possible for these same people to enjoy recreational activities denied to most city dwellers a few decades ago.

What this all adds up to is that between 1940 and 1950, 80 percent of the increase in national population took place in the Standard Metropolitan Areas of the country and that from 1950 to 1956, this figure grew to 85 percent. Almost 69 percent of this increase in metropolitan population was outside the central city and 41 percent was outside the denser urbanized area. Today, some 60 percent or more of the population is located in the officially designated Standard Metropolitan areas, and it is predicted that by 1975 there will be 60 million more people in these areas than in 1950. By the year 2000, it is anticipated that as much as 97 percent of the increase in population will be concentrated in urban areas, which are expected to double and treble in these next decades.

The explosive spread of people outward from the center of the city, as we all know, has brought with it a multiplicity of problems. Much is being written about these problems and there is therefore little need to dwell on them in detail here today. Generally speaking, however, most of these so-called "metropolitan" problems appear to arise as a result of the multiplicity of governments or, if you will, the fragmented nature of local government in these areas. Indeed, it is this fragmentation which in large measure prevents us from applying already available scientific and engineering knowledge to the solution of what often are otherwise relatively simple problems. But in the face of this situation, cities are finding that it is no longer politically feasible or expedient to extend their boundaries by annexation to meet the accelerated sprawl. Thus the so-called metropolitan area, including the city and surrounding built-up areas, may extend over sections of several adjacent counties, numerous smaller municipalities and other taxing units or even across the boundaries of neighboring states. In the average metropolitan area there are 95 separate units of government. The Chicago area has 960 and New York 1071. As a result of this situation, the provision and financing of public facilities and services, and the regulation and control of land use for business, residential, recreational and other purposes is, to say the least, confused and generally uncoordinated. The problem is not only what kinds of facilities should be provided on a regional basis but what kind of governmental structure is required to bring orderliness and efficiency to this process.

Various students of government have from time to time suggested the creation of some form of super government or Metro, as it is often referred to, as a means of handling those functions in metropolitan areas which transcend local jurisdictional boundaries. Other suggestions envision some form of federation of the numerous local governments of the area as a means of dealing with common issues and objectives. So far, however, only one metro has been created in the United States. This is in Dade County, Florida, and it has the great advantage of being located entirely within one State and one county. Another often cited example is, of course, the Metro government of the Toronto, Ontario, area. Generally speaking, however, it may be a long time before a satisfactory form of integrated metropolitan government is found. In fact, since each metropolitan area appears to be, in some respects at least, unlike any other, there is no assurance that any one form of super government will provide the answer. In any case, the general attitude of local citizens in each of the smaller units which comprise a metropolitan area toward a super metro form of government is one of suspicion and is likely to forestall adoption of such a government in most areas for a long time, no matter how badly this is needed.

With respect to specific services, such as water supply or sewerage, regional authorities, special districts, ad hoc organizations or simple cooperation is, of course, sometimes resorted to with complete success, but there appears to be little likelihood in the near future of a general acceptance of a comprehensive regional government with broad powers of taxation and administration, no matter how badly this is needed.

This situation is not necessarily altogether bad. As Dr. Robert Wood of Massachusetts Institute of Technology pointed out, identification of the local citizen with the smaller communities and local governmental areas which make up a metropolitan region appears to hold for him values which he prizes highly and which he would perhaps be forced to forego with the adoption of a regional form of government. Dr. Wood also points out that, pending the invention of acceptable forms of regional government, much can be achieved by cooperative effort between the several units of the area, both in regional planning and in the provision of various services. This has been our experience in the Baltimore region. I should like now to discuss these experiences as an illustration of one approach to the metropolitan problem.

From the point of view of governmental structure, Baltimore is one of the more fortunate metropolitan areas of the country. It lies entirely within one State and the city proper is completely independent of any of the surrounding counties. There are only five counties within the area of metropolitan influence, and only five other incorporated towns, all of which are well beyond the outer fringes of the urbanized area. School districts are co-terminal with the counties. Special Sanitary Commissions operate in parts of four of the counties under rules which readily permit their boundaries to be advanced as need for services arise. The only other sub-divisions are precincts and election districts which primarily serve a statistical purpose. Thus, any organization of local representatives assembled to deal with area problems is usually small in numbers and is thereby more likely to be able to arrive at meaningful decisions.

The principal problems or difficulties resulting from the fragmented nature of local government in the Baltimore area are similar to those in most other metropolitan areas. They are concerned primarily with regional land use planning and control, including provision of parks and open spaces; water supply, sewerage and sewage treatment facilities; traffic and transportation facilities; and the financing of these various activities and works. There are a number of others, of course, but these appear to be the areas of greatest concern.

These problems have been recognized by thoughtful officials and citizens of the region for some years. In the absence of any overall regional agency to deal directly with them, and little prospect of establishing one, the Maryland State Planning Commission, in 1956, brought together officials from the city and the five surrounding counties to discuss ways and means of coordinating the planning and provision of public facilities in the region. Creation of an ad hoc organization, known as the Baltimore Regional Planning Council, resulted from these discussions. The Council consists of the elected head of each jurisdiction together with the director of planning for each area plus the director of the Maryland State Planning Commission as chairman. The representatives are appointed by official action of each jurisdiction, but the Council has no legislative basis for its existence.

Through the Planning Commission, a Federal grant from the Urban Renewal Administration was arranged which permitted the Council to embark early in 1957 on a series of six specific area wide studies. The grant is matched through pro rata contributions of staff time and services by all of the member agencies. The studies cover population projections, development of a regional land use plan, projections of industrial growth and locational requirements, and arterial highway, water supply and sewerage needs. These studies are now nearing completion and a second matching grant has been requested to finance additional studies suggested as a result of the experiences in this first effort. The value of the Council to the region has already been recognized, however, and a bill to establish it on a permanent basis has now been prepared for introduction in the legislature. If this is passed it will create a council of somewhat different membership composition, but its objective will still be the coordination of planning for land use and for the provisions of public facilities in the entire region.

With respect to the studies so far undertaken, a more detailed discussion of certain aspects of two of them will, I believe, enable you to gain some idea of how cooperative efforts can be used effectively to achieve useful results in the absence of a comprehensive government. The two work items which I have selected should be of particular interest to this conference because they deal with regional park, recreation and open space requirements and with the problems of sewage disposal in relation to river pollution.

The City of Baltimore now has a splendid system of public parks, which provide about a half acre of park area for each 100 persons. As population expanded into the surrounding counties, however, the local governments were unable to make provision for comparable parks to augment this city system. Large areas adjacent to the city are already solidly built over. Future population growth threatens to engulf the entire region for some miles outside the city, including presently unoccupied stream valleys. It is essential, therefore, that steps be taken soon, not only to acquire parks needed now, but to acquire the necessary reserves of land for the future parks, open spaces and buffer zones. These are needed as separators between communities, neighborhoods and industrial areas, for the preservation of the amenities of neighborhood life, and to provide facilities for an expanding recreational demand induced by higher living standards, shorter working hours and almost universal personalized transportation.

In approaching the problem of open spaces as a facet of land use planning, the Council was confronted with the fact that no satisfactory standards for determining how much open space should be provided for what purpose has yet received general acceptance. Accordingly, a working committee drawn from the various State, county and city recreation, park and planning staffs of the area was established to try to devise such standards. Guidance was also solicited from the National Park Service. An inventory of all existing park, institutional, military and other open spaces of the region was undertaken, and a canvass was made of standards followed in other areas of the country. Consideration was also given to the changes in recreational activities which modern living standards have brought about with particular reference to the increased demand for non-urban types of recreational areas.

However, while the committee was primarily concerned with the development of standards for major parks, recreation areas and open spaces serving the population of the entire region, it also considered standards for local facilities.

After considerable study, the committee proposed the following standards.

DESIRABLE STANDARDS FOR GREEN SPACES

Type of Use	Acres per 1,000 Population
Neighborhood parks, play fields and playgrounds	4
Urban parks	10
Regional and state parks, parkways, etc	10
Total Public Parks and Recreation	24
Open spaces	33
Total	57

The committee suggests that the first two standards for neighborhood parks, playfields, playgrounds and urban parks may reasonably be expected to be valid through 1980, while those standards for regional and State parks as well as for open spaces ought to be reviewed within five years. They anticipate that a shorter work week, which would result in more leisure time and longer periods of paid vacations would establish an increased demand for regional and State parks and that a standard higher than 10 acres per 1,000 persons may be desirable on a longer range basis. The State parks referred to here are only those which would be located within the five county metropolitan region.

The trend of institutional users of open space, such as hospitals, private schools, etc., to move away from congested areas of the central city and seek larger sites on the fringes of the urban area may also necessitate an upgrading in the future of the standards for those uses.

As has been pointed out, the recommended standards are based on the best judgment of the committee members and must be considered in that light. Whether these standards are justified is not now measurable since very little technical study has been accomplished nationally in this aspect of planning. However, public and professional planning concern over preservation of adequate open space suggests that the standards point in the right direction.

More detailed analysis of this problem, including the financing and management of a regional park system will be included in the next series of studies. In the meantime, the individual counties are now giving consideration to the findings of the Council to their own land use planning, and the Department of State Forests and Parks is applying them in planning for a major system of river valley parks in the area. Appropriations are now being requested for a 12,000-acre river valley park addition to the State parks of the region.

One aspect of planning for the river valley park system which I am sure will be of particular interest to most of you here today concerns the problem of the recreational use of water supply reservoirs located on some of the river valleys. Six such reservoirs totalling over 28,000 acres of combined land and water area are located in the region. The water from all these reservoirs is fully treated before consumption. Fishing, both from rowing boats and from the shore, is now permitted at all of them, and tables for a limited amount of picnicking are provided. At two of the Baltimore city reservoirs horseback riding is allowed along the fire break trails and bow-and-arrow hunting for deer is permitted at one. A golf course has also been constructed on one reservation. It was felt, however, that these reservoirs offered a much greater opportunity for recreational use than was being taken advantage of and explorations were undertaken to determine what would be involved in opening up these areas.

For this purpose the Council undertook joint discussions with State and local health officers, recreation and water department officials and representatives of the Department of State Forests and Parks and of the State Game and Inland Fish Commission. Experiences at reservoirs elsewhere in the country, such as at Springfield, Illinois, where full use of the reservoir for recreation is allowed, were also solicited. As a result of these investigations, it was generally concluded that within certain limitations, there was little reason on sanitary grounds for restricting use of such raw-water reservoirs for recreation, where full treatment of the water is provided before consumption. There appeared to be reason to fear public reaction to some uses, however, unless the public were fully informed on the safeguards provided, but beyond this, the principal deterrent to the recreational use of these facilities appears to stem more from difficulties of a legal, financial or an administrative nature.

The group concluded that "over a period of time, and with careful consideration of all aspects of each problem, existing uses could be greatly expanded and many additional uses might ultimately be permitted, including such things as general use of small boats and canoes, sailboating and ice skating in selected areas, and eventually, on a trial basis at least, swimming.

"The basic problem appears to be one of working out cooperative arrangements between water departments and those other State and local agencies who would be in a position to cooperate in the establishment, management, financing and policing of these other activities. Since some of these uses are already permitted, accomplishment of the ultimate goal appears to be primarily a question of continued cooperation and planning between the various interests involved, but this process should probably be undertaken on a more organized and accelerated basis." The Council is now seeking ways and means of implementing these suggestions.

The second area of study which I want to discuss deals with sewage disposal. A major problem arises as a result of widespread land development in the absence of public sewerage facilities in the outlying suburban and exurban areas. With few exceptions individual septic tank systems have been installed to handle domestic sewage in these areas. Much dissatisfaction over the performance and cost of these systems has been expressed by both home owners and public officials. Even under the best of circumstances, these facilities frequently break down after five or six years, and surface overflows cause both unsightly and unhealthy conditions. Surface wash under these circumstances causes considerable pollution of nearby streams. On the other hand, small community sewerage systems and treatment works, which, under proper management might well provide a reasonable solution to the problem pending ultimate connection to a central disposal system, have been frowned upon by health authorities, largely because of unhappy past experiences with them.

In view of the fact that the larger streams and rivers of the region to which the smaller streams are tributary, are all dedicated to public water supply or to recreation, fishing and park development, the attitude of the health authorities can be understood. However, the pressure of population growth and the increasing public nuisance and private expense created by the septic tanks, together with the difficulties in controlling land sub-divisions, resulting from their indiscriminate use, indicated the need for a fresh approach to the problem. And since the septic tank problem was common to all of the outlying jurisdictions, a regional approach appeared to be justified. The Regional Planning Council accordingly called a meeting of representative officials and citizens of the region to discuss the problem. This resulted in the appointment of a working committee of health, sanitary, engineering and planning officials, under the leadership of the State Health Department, to study the problem in more detail.

This Committee concluded that reliance on septic tanks was generally to be discouraged and recommended the following course of action.

1. A comprehensive Master Sewerage Plan for the extension and financing of interceptor sewers throughout the region, should be developed. It should coordinate all related aspects of planning, zoning, engineering and economics so as to delineate those peripheral time bands or zones of the urban fringe into which interceptors might be extended within 5 years, ten years, more than ten years or never.

2. The development of all large sub-dvisions (50 or more houses) should be discouraged if not located in the five-year time band. Within this band any sub-division development in advance of actual interceptor construction should be provided with community sewers connected to temporary treatment plants of suitable design and location. If this is impracticable, individual septic tanks could be permitted as a temporary expedient provided community sewers (including collectors, laterals and house connections), were also installed and "capped" pending extension of interceptors.

3. When proposed developments fall in the 10-year time band, sewage disposal should be accomplished by means of community sewers connected to community treatment plants discharging into a stream of sufficient size to assimilate the effluent, the treatment to be of the highest degree necessary to protect the public interest. The plant should be considered permanent. Beyond the 10-year zone the requirements governing sewage treatment should be even more stringent or, as an alternative, septic tank disposal might be used provided lot sizes are large enough for future reconstruction and the soil is demonstrated by test to be satisfactory for underground disposal.

The report of the committee was endorsed by the Council and distributed to the officials of all of the constituent local jurisdictions, with the recommendation that its provisions be applied in connection with land use planning, sub-division control and the provision of sanitary facilities. Preliminary steps are also being taken looking toward preparation of the recommended Master sewerage plan for the region.

Still another aspect of the sewerage problem has to do with inter-jurisdictional and inter-regional use of a river for multiple purposes, including sewage effluent dilution. Baltimore, and its nearest neighbor, Washington, are only 38 miles apart and the two regions are growing toward each other at a startling rate. The Patuxent River forms the boundary between the two regions. Two reservoirs on the upper reaches of its main stem provide water for suburban Washington. Sewage plant effluents from the town of Laurel and from Fort Meade, located in the river's middle reach, utilize all of the dilution potentialities of this portion of the stream. The Middle Branch of the river provides water supply for Fort Meade and receives sewage from State institutions and a small town in Howard County. Anne Arundel County and Howard County, both in the Baltimore area were each pursuing their own separate plans for handling sewage arising in their portions of the basin, with Howard County preparing to dispose of this sewage through the treatment facilities of Baltimore City. The latter scheme does not meet the wholehearted approval of the city. Finally, the State is proposing to develop some portions of the river valley for park and recreational purposes.

Here is a situation where obviously a master plan for the whole basin is required as a more efficient approach to a solution of the individual problems of the several jurisdictions concerned.

In order to resolve this situation, the Baltimore Regional Planning Council brought together the representatives of all affected jurisdictions for preliminary discussions and then established a committee under the chairmanship of the State department of health, to work out acceptable procedures for preparing a master plan. This committee has now proposed a comprehensive study by a consulting engineering team, to be financed on a pro rata basis by all affected interests including the State. The plan appears to have a very good chance of being adopted. A similar cooperative approach to the inter-jurisdictional use of the Potomac River in the D. C. area is now being initiated.

I believe that these experiences in the Baltimore area clearly indicate that the absence of a regional or super-government need not prevent the accomplishment, on an informal or voluntary basis, of effective coordinated planning for a metropolitan region. In fact, we are beginning to feel that the most valuable results of our Baltimore efforts are not necessarily the specific regional plans or studies being produced, but rather the good working arrangements and the spirit of cooperation between the officials of the various local jurisdictions and State agencies, which has been engendered as a result of the Council's activities.

DISCUSSION

VICE CHAIRMAN MEYER: I am sure that in discussing urban sprawl Mr. Scheidt has pointed out a very concrete problem that is familiar to every one of us. I believe that we all realize by his figures alone that for recreational use in the cities we only have an area about as large as a small living room for each man, woman and child in the city if all the people utilize the land at the same time in the parks. That isn't much room for people in the city to enjoy themselves in and get away from the frustration and tension of city life. I am sure that all of us are aware of the problem involved and we are also very definitely aware of the need for stream pollution control. It is a thing that we just must do and I feel very certain that some of you will want to ask Mr. Scheidt some questions or make some statement relative to this problem which we face, which is vital to the health and well-being of our cities.

Does anybody have something they would like to say in connection with this?

MR. RICHARD COLE [Pelham, New York]: Would you care to comment on the wisdom of New York City disposing of its surplus watershed lands adjacent to the city at the same time that its city residents are being denied the parks in surrounding counties?

MR. SCHEIDT: It seems to me that the obvious comment to make on that is that if New York City is anything like the several cities, Baltimore and Washington, that I am familiar with, it hasn't enough recreational land to start with. I would certainly think that an examination of the total available recreational areas for the New York area ought to be undertaken before a disposition of any of these lands was undertaken.

MR. JOHN BAKER [National Audubon Society]: Not only from the standpoint of the Society, but I happen to be a member of the Open Space Committee, which is concerned with seventeen counties in and around Manhattan. If I understood you correctly, you used the figure of 57 acres per thousand people as a minimum need. Am I right?

MR. SCHEIDT: That's right.

MR. BAKER: I am wondering if it is more important to establish the maximum number of people per thousand acres. Has that been given consideration?

MR. SCHEIDT: Yes, but the committee that was appointed to study this problem felt that at this stage in the game they didn't know enough about the ultimate needs and the standard that they did recommend is so far beyond what is presently being provided that they did not feel justified at this time in going further.

They clearly pointed out in their report to the Council that they frankly admitted that this was arbitrary, that they felt it was in the right direction but they couldn't just define it in terms of any concrete evaluation, and that a great deal more study was needed. I feel myself that, before we can satisfy this problem, a great deal more analysis of the whole recreational and open space problem in the urban areas is going to be required.

I am hoping that Mr. Rockefeller's Committee as well as a number of local committees around the country will presently be able to come forth with some figures on this problem which will help us to more clearly define what we will require in the urban areas.

This is frankly arbitrary at the present time, however.

MR. BAKER: Wouldn't you agree that at some stage a reasonable upper limit of human use be established before the values of the areas as open space are destroyed for all time?

MR. SCHEIDT: Yes, there is definitely a need for determining that.

MR. BAKER: In other words, at a certain point of saturation the spaces cease to be open.

MR. SCHEIDT: Precisely, sir.

VICE CHAIRMAN MEYER: As a boy living in the western edge of the city of Philadelphia I could walk in five or ten minutes a little less than a mile to the edge of the city. I could then walk six or seven miles out into the country to a Scout camp that we had and now as I go back to this area, twenty-five years later, I see that it is almost continuous suburban development. It runs right on out to West Chester and the other smaller cities and so we no longer have the type of recreational facilities that we had a generation ago. It is a really important problem and I think we all have a lot to think about in what we may do for the future.

RURAL SHRINKAGE

EDWARD HIGBEE

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The growth of America's population creates an extraordinary competition for space, particularly in those densely settled counties which the Bureau of the Census calls standard metropolitan areas.[1] Between 1950 and 1956 the nation's population increased by 15 million. Of these, 13 million were in 168 standard metropolitan areas which contain the largest cities and their environs. Not only is population expansion characteristic of metropolitan counties but most new residences are emerging in suburban districts rather than in central cities. In the same 1950-1956 period while central cities gained 4.7 per cent in population, their suburbs made a leap of 55.8 per cent. Because suburban growth consumes more land per capita than city growth, farms are disappearing at an accelerated rate, and this shrinkage of agricultural space has now become a conspicuous associate of population growth.

The combination of human increase and the replacement of farms by suburbia has already created public waste because of the disorganized ways in which it has occurred. Increasing social and economic difficulties lie ahead. Although there is now surplus agricultural production, this cannot persist indefinitely under the twin assault of human multiplication and farm subtraction. Of equal importance, and certainly of more immediate concern, is the probability that, as farm shrinkage continues, little open land will eventually remain between the suburban outposts of abutting metropolitan

[1]A standard metropolitan area is a county or group of contiguous counties (except in New England) which contained at least one city of 50,000 inhabitants or more in 1950 or subsequently. In New England the S.M.A. is defined on a township, rather than on a county basis,

areas. Unless precautions are taken, whole regions such as that between Boston and Washington, which geographer Jean Gottmann calls Megalopolis, are destined to become built-up complexes of fused cities and suburbs—their environmental patterns of buildings and streets rigidly set. The prospect for flexibility in landscape use is being lost at a time of drastic technological change when the solvency of communities demands that they accommodate more people every year without either congestion or costly demolition and renewal.

There is as yet little public concern about the disappearance of agricultural space because food production per acre and per farmer has increased faster than total population in recent years. Between 1950 and 1956, while the U. S. population increased 9 per cent, total agricultural production increased 14 per cent. A unique situation which also contributes heavily to present surpluses is the fact that almost 20 per cent of present cropland had been used to raise feed for horses and mules until recent decades. There are now so few of these animals left that very little acreage will ever again become available in that way. Nevertheless the rapid disappearance of draft animals since 1920 has left the American farmer with an oversupply of land on which he is raising surpluses.

Farm surpluses are at the moment a matter of national anxiety chiefly because taxes are levied to subsidize their storage or their export at less than market value. A major share of these surpluses, while they clog the domestic market, do not reflect overproduction so much as a lack of consumer purchasing power in lower income brackets. The enormous quantities of grains now in storage could be greatly reduced by conversion to meat and dairy products if all American families could afford to buy these more costly types of food. The nutritional need exists, but the purchasing power does not. If, as they should be, the nutritional levels of the American people are improved; then in the future full production would be desirable.

Now, disregarding real needs, and looking at present market conditions, as long as surpluses are substantial the prices of agricultural goods will remain somewhat depressed. Under these circumstances the permanent loss of good cropland to suburban development is not lamented by farmers; rather it is welcomed by most of them. Those who sell benefit from capital gains on their real estate. Others benefit incidentally by reduced competition. While surpluses persist, the advance of suburbia into agricultural districts will not affect the retail prices of food quite as much as would otherwise be expectable. Thus, there is likely to be little consumer alarm as cropland continues to shrink, until this shrinkage reaches a critical point. There has been no real concern up to now except on the part of conservationists who recognize the ultimate dangers of wasting good agricultural soil at a time when the population is growing like compound interest.

On the eve of the American Revolution the total population of the 13 colonies was about 3 million. Now there is a net gain in the national population of about 3 million persons annually. A little over 100 years ago in 1850 the population of the U. S. was 23 million. We have grown by more than 23 million in the last 9 years. Within a century, at present rates of growth, the population of this country could equal that of China today (about 650 million). Will there then be an adequate agricultural base? Will the landscape be useable efficiently if by then whole galaxies of cities and suburbs have coalesced into continuous built-up areas and transportation arteries have become encrusted with barnacle-like growths of residences and businesses? It is time to recognize that there is only so much space in the metropolitan areas where dense populations are collected. Since the potentialities of human proliferation seem unlimited, and because as yet birth control seems to be for the other fellow's family, there is a growing need to plan how space may be used to accommodate growth without cramping and confusion. *In metropolitan counties in particular we must recognize that we are faced with an unlimited pressure exerting itself upon a limited space resource.* The disappearance of farm land in the environs of cities is estimated at about one-half million acres annually. If the present methods of suburbanization continue, the amount of space consumed will increase each year to keep pace with human multiplication. Probably the rate of loss will reach one million acres annually by the end of this century. From the standpoint of food production, this is serious because not all farmland is equally valuable for crops. Unfortunately, in the environs of cities the ratio of good cropland to total farmland runs very much higher than in the country as a whole. This is because cities are commonly located in especially favorable places—usually on plains or on valley floors rather than on hill or mountain sides. They are generally surrounded by better drained land and the soils are often deeper, richer, and less subject to erosion. Most cities are located in humid regions where natural rainfall is adequate for crop production. Important cities in desert areas are invariably in river valleys or in basins where water supplies are available. This is also where the best farms in desert areas are located. Some of the strongest competition for space between farm and city occurs in the oasis communities of desert regions. Sprawling Los Angeles is the classic example of suburban encroachment upon a limited agricultural resource. Already more than half of the tillable land in the Los Angeles district has been converted to suburban uses.

New Jersey, which is caught in a squeeze between the expanding outposts of Philadelphia and New York, has on the average the most valuable farm land of any state in the Union. Good and poor, all together, it averaged $403.73 per acre at the time of the last agricultural census in 1954. By comparison, the average value of farm land in Iowa was $198.86 an acre, and in California it was $226.71. About 21 per cent of New Jersey is suitable for cropland. The balance is chiefly woodland and pasture poorly suited to tillage. Not at all by coincidence, but rather because the best agricultural sections of New Jersey are also the most highly urbanized, the New Jersey Turnpike was constructed on some of the state's best soils. This toll road carries some of the heaviest interurban traffic in the country. Along its route it is breeding new residential and commercial zones. Fortunately they have only limited access to the turnpike, but nevertheless the great convenience of this road has prompted such development particularly near the interchanges.

From the standpoint of New Jersey's agriculture the selection of this particular route has been disastrous. With four-fifths of the state covered with non-arable soils, it is unfortunate that some of the poorer lands were not chosen for the right-of-way even though it might have involved running the road a few miles longer. It is time to recognize that a highway may not only consume arable land itself, but it can foster additional losses through the urban and suburban development that it engenders. Our engineers, planners, and politicians should recognize that the most efficient highway, if routed over the best agricultural lands, may contribute to lower dietary standards in the future, especially if they consider the stimulus that good roads give to peripheral development.

In planning the future growth of cities and suburbs this same principle should be observed. While subdividers and land speculators may prefer to deal with level acreage free of stones, trees, and other hindrances to cheap construction and fast turnover, it is time to consider that tillable soil of the best quality is a very limited resource. With good care, it could go on producing food as long as man inhabits the earth, but once covered with asphalt and brick it is finished as cropland.

The average consumer may not realize how the present spread of suburbia over tillable land will ultimately affect his pocketbook even though, for the moment, it does not threaten his food supply. The displaced farmer often continues his profession. To do so he either bids up the price of a going farm in order to acquire it, or he goes onto submarginal land not previously cultivated. There he may invest in land clearing, or in drainage engineering if the land is marshy, or in irrigation if the soil is droughty. In either case he raises his capital investment in land beyond previous levels. He can afford such investment with some of the capital gains he made in selling to suburbia. But by investing more in this next farm, he raises his costs of production. These greater costs are ultimately recovered when he markets his goods. In recent years we have seen farmers come to Delaware from Long Island and northern New Jersey where they sold out to suburbia. We have seen the value of farm lands increase as these newcomers have helped to strengthen our real estate market by their generous offers.

The more farmers that are displaced by suburbia, the greater will be the inflation of nearby agricultural acreage. Ultimately the suburbanites who displaced the farmer will pay a larger percentage of their incomes for food. It is a fact that while yields per acre on the average American farm are increasing, the cost of each unit of increment is also rising. We are raising more food, but the costs of production are going up even faster.

In many instances the farm community on the edge of cities could, if it wished, secure the zoning of agricultural land to prevent the encroachment of suburbia as well as the increased taxation of farm property which comes with suburban intrusion. But generally the prospect of quick capital gains is more attractive to landowners. When Fairfax County, Virgina, recently zoned major rural areas and imposed a 5-acre minimum upon house lots in agricultural districts, the farmers themselves protested in court and succeeded in having the ordinance invalidated. They objected because they could not secure maximum prices for their acreage as long as the lot-size restrictions applied. It is not reasonable to expect that the average farmer will forego without some compensation, perhaps in the form of development easements, the speculative advantages of land ownership. Population increase is the best guarantee that land values will increase substantially, and the average owner naturally wants to take advantage of a favorable sale if the spread of suburbia comes his way.

While the individual landowner is knowledgeable in these matters, the voting public seems particularly naive and indifferent. Most citizens have no acquaintance with real estate beyond F.H.A. and G.I. mortgages which have less to do with property values than with easy credit. Under the circumstances, they do not realize how fantastically open land increases in value as it passes from farm to suburban development. Given time, which is another way of saying, "let population pressure develop," an acre that is worth no more than \$400 as cropland may be worth \$4000 as houselots. This can and does happen very frequently in a matter of 10 or 20 years.

Obviously with suburban expansion, the very rural attractiveness of the first developments disappears as subsequent subdivisions take their place next door. Gradually the former countryside becomes filled with homes, streets, roads, and roadside businesses. The pasture and fields where children played sprout with split-levels and ranches. The chance to buy nearby open space for parks and recreational areas is lost. By that time, what was cheap land farther out has become ripe for additional subdivisions and, in the minds of many, is too costly to buy for parks. By procrastination, suburban communities commonly fail to protect their recreational and aesthetic needs until it is too late. The next generation of parents to come along will find these areas quite unattractive to the eye or for the rearing of their children. They will bypass them as the present generation of parents has by-passed the congested areas of cities. Thus, by present public land policies, or lack of policy, we practically assure the development of rural slums.

These rural slums will become an even greater fiscal and social problem than the urban slum because they will be more extensive. Also, they will never have the special locational advantages which will warrant costly renewal programs such as are justified in the hearts of cities where land gains in value almost as rapidly as buildings decline in value. Geographical position near the social center of gravity will always have intrinsic worth. Eccentric locations can never acquire this value. Suburban growth is dispersed and eccentric, while city growth is compact and central. Ultimately, as buildings wear out, most suburban land will have little real estate value, principally because the original cost was rather artificially inflated by liberal credit and it lacks intrinsic locational advantages.

By what means might some practical steps be taken by our suburban communities to reserve at least some of the open spaces around them and thereby protect their future ability to accommodate more people without congestion? Good parks and recreational areas will always attract the parents of every new generation. Real estate values are likely to hold up in such suburban areas bordering parks just as real estate values and the good quality of neighborhoods hold up in urban areas adjacent to parks that are well maintained. What steps might be taken to preserve the better agricultural soils for farming and to steer the course of subdivisions, roads, and commerce onto inferior lands? What can we do to set aside space for future limited-access roads that will link our communities without frustration and congestion? Admittedly there is little surplus in the budgets of any local community for this purpose, yet it is urgently necessary that measures of this kind be taken for the future welfare of the

American family and for the welfare of the community and nation.

In our society which respects the rights of private property it is unethical to exercise discriminatory public control over the use of private property except in extraordinary circumstances. For instance, it would be unethical to permit one farmer to sell his land for great profit to real estate developers and to deny this privilege to his neighbors on the grounds that their acres should be conserved as open space until the community is ready to buy it or release it for approved purposes. Civic plans are human instruments, and maps can easily favor one man and penalize another. Not a few zoning maps have been drawn with such thoughts in mind which is why they are so often ineffective.

The capital gains tax on real estate which is now collected by the Federal Government for revenue purposes should be returned with all possible speed to the individual communities in order that they might use those funds to buy open land for future public use. Capital gains taxes on real estate are actually the product of local community growth and should properly be returned to the local community by the Federal Government undiminished, but with the proviso that they be used only to acquire space for future roads, parks, reservoirs, disposal areas, etc. Such funds should also be used to purchase development easements from those farmers possessing better soils who would be willing, for a price, to reserve their lands as farms. The capital gains tax on real estate should be regarded not as revenue, but as a vital instrument in long-range community planning.

America is no longer in that pioneer stage when it was desirable to settle land. The problem now is to avoid settlement where it is likely to damage the function, convenience, and beauty of a landscape when populations are concentrated. In the formative stages of American civilization it was desirable to dispose of public lands to stimulate pioneering, settlement, and development. Today our needs are quite the reverse. It is now desirable that some private lands in metropolitan areas be reacquired by the public as quickly as possible so as to forestall a kind of environmental *rigor mortis* that could seriously cripple the economy at all levels of government. Growing population pressure will change our basic conceptions of what is wise land ownership and wise land use in areas of concentrated settlement. By using capital gains taxes on real estate as revolving funds, communities could buy all private properties on their peripheries at market prices. They could then resell some lands, but with restrictions which would assure that their use would conform to the best interests of their growing populations. The best soils should be reserved for agriculture, and certainly the communities should retain strategically located spaces for parks and roads.

DISCUSSION

VICE CHAIRMAN MEYER: Dr. Higbee has brought us a message on a subject with which perhaps most of us are not so familiar with as we are with the previous speaker's, but I assure you that it is a message which all Americans must hear and they must hear it time and time again.

As Chairman of the Vermont Land Use Conference I have been quite familiar with this problem. In motoring from my home in a small Vermont hill town, a farming town where most of the good agricultural land is concentrated along the river bottom, I noticed the changes and then when I got about 15 miles away, in New York, I couldn't help but notice that on some of the very best river bottoms the houses and other buildings only a few hundred feet apart.

Now, what does this do? It isn't only the house lot; it is the fact that these developments take away some of the best fields of the farms, and they take away the intervening land, because under modern methods of farming, tractors, balers, and other big machinery, can't operate effectively going in and out of corners. This means that we are losing a tremendous amount of our best land what amounts to be the heart of the farm. Therefore it has knocked the whole farm out of production because a farm isn't an economic unit without this better land. It is a great problem in that respect.

It is a great problem in another respect. As I got closer to the Albany airport, I couldn't help but notice that design of some of the stores and houses was such that they didn't efficiently utilize the land. They marred the landscape; took away its beauty. It is really a tremendous problem.

DR. WILLIAM VOGT [Planned Parenthood Association]: It seems anomalous to me that in a Wildlife Conference where one of the basic techniques of management is the control of population either up or down, there should have been so little discussion this afternoon of the problem of human population control in this country. We actually have it. We give substantial incentives to larger populations through tax relief for more children, subsidies for children—for example. New York City spends about $100 million a year in aid to dependent children, that is, supporting children that cannot be taken care of by their families. I wonder whether it isn't time for the planners and for the citizens of this country to think about developing a more positive population program, which can be done through such things as what has been called "disincentive," that is, in sharply rising taxes for larger families.

Dr. Higbee mentioned birth control but he seemed to take rather a fatalistic view of it. The Japanese have cut their birth rate 50 per cent in ten years. We obviously cannot hold on to values that mean so much to us in this country if our population continues to increase. Some day we have got to get around to having some kind of a population policy, and I would like to ask either of the last two speakers if they would comment on the importance of that technique.

MR. SCHEIDT: I know nothing about the subject, which makes me an expert, but I would like to comment to this extent, that I listened with a great deal of interest the other night to a lecture by a series of learned men, a lecture which was sponsored by Resources for the Future in Washington, and the chief speaker was Professor Beadle, the Nobel Prize winner in genetics, and this question did come up and all of the gentlemen who were present raised the question quite seriously as scientists.

They posed the question and when questions from the floor were directed to them they took this stand, that they as scientists could very well tell what was happening and they could point a finger at the breakdown of genetic heritage as the result of the salvaging of poor genetic stock through medical programs as well as the increase in radiation, which is creating some problems, but they said they could, as scientists, go no further than that, that beyond that the problem was one in the social and the political sphere, and I think my only comment today, therefore, would have to be that I, like the last speaker, am somewhat fearful about this whole program of increasing population, the whole trend, but that it is something that we have some scientific information on, yes, but which has to be dealt with at the social and the political level and that is where I think we have to do some starting and some thinking.

VICE CHAIRMAN MEYER: Do you have anything to say, Dr. Higbee?

DR. HIGBEE: I have just one comment. The reason I am a skeptic about birth control, Dr. Vogt, is that I want to scare people so that they will listen to you more.

DR. VOGT: I think that conservation inevitably involves social and economic backing. We are having an awful hard time to get people to help in various parts of this country. I am suggesting that similar educational techniques might be used in connection with human population. Simply because they are not biological problems is no reason for avoiding them. There has got to be a limit some time and under the best of circumstances it is going to take several decades to change our mores, to get an acceptance of a changed attitude, and therefore it seems to me that the sooner we begin on it the better off we will be.

CHAIRMAN HALE: Thank you, Dr. Higbee. That was a very provocative talk you gave.

There is one point I wanted to just elaborate on a little bit that Dr. Higbee spoke of. I want to remind you that when we take open agricultural land and cover it with concrete and asphalt, we are in reality converting a renewable resource into a non-renewable resource.

It is obvious from our discussions this afternoon that all types of land, which is one of our greatest resources, all types of land need planning.

ON PRESERVING THE WILD

DAVID R. BROWER

Executive Director, Sierra Club, San Francisco, California

"Pink" Gutermuth told me about the subject assigned me for this afternoon, thinking, I'll guess, that I might be able to take this subject almost anywhere and probably would. I shall try to take that subject somewhere, but I hope I don't go it alone. It would be nice if you came along too.

The State of California has sent me here, unknown to any of you, on a secret mission. The news has probably been kept from you but the story is being given credence out on the Coast that New York is about to make way, within the next decade, for California: the land of sunshine, oranges, and Forest Lawn is about to become the nation's most populous state. So I have been sent back here on a search for space, for land on which California can resettle its surplus citizens.

I wish that this pretense were as humorous as it is ridiculous.

But it isn't. Since I left San Francisco, at the beginning of this month some four thousand people have added themselves to the California population permanently—and the number is permanent even if the people are mortally not so. This sort of addition has been going on all year, ever since the War for that matter, and isn't ject almost anywhere and probably would. I shall try to take the expected to slow down. This is what causes our earthquakes, such as the one the papers just reported, although no scientist has yet made the announcement. You see, the land is merely adjusting itself to the weight of the new people! So now suburban sprawl has spread the full thirty miles south of San Francisco along both sides of the San Francisco Bay. For each new house there is at least one new automobile, in keeping with the current conviction that every man needs two tons of steel to get him from his bed to his desk and some 300 square feet of pavement to park the steel on at both ends of the run. Mass transportation is withering, but we are solving this little annoyance with vision and vigor.

We solve our problem with what you call throughways and turnpikes and what we call, by strange semantic twist, *free*ways. Why free? I don't know. Not in money, for they cost millions. Not in land, for they cost us thousands of acres of our most productive soil. They aren't free in movement, either. Our engineers boast that we can travel half the length of the Bay without meeting a stoplight. (Our Spanish predecessors could make the same claim!) But they're talking in pleasant theories, not of actual fact. All too often and rush hours find a given freeway jammed bumper to bumper and the array of stoplights stretched out before you is something to behold. Our most popular disk-jockey program at rush hour spends less time on music than on news of the latest jam, and what route you should try to take to get around it, if you're not caught in it yet. Some of our freeways become obsolete before the ribbon is cut in our standard opening ceremony.

That, in a slightly distorted view, is how we are solving our problem. And if Northern California thinks it has a problem, you can pardon Southern California for laughing. Their growth is three times as fast as ours. No need to worry, of course. After all, the universe is an expanding universe.

So we'd like to expand your way. What can you offer? How many half-acre lots, with space for a 3- or 4-bedroom ranch house plus garden? With plenty of good schooling near by. Not far from where we want to work. Smog-free. A small park close by—where the children can find playground apparatus, the youths can enjoy big-muscle play, where the parents can stroll and unwind the week's tension, and where elders can sit and watch and remember when the days weren't so tense.

And by the way, can you add to these things, what with the shorter work week and longer vacation we're counting on—can you also add some untrammeled seashore and mountains?

I suspect that I've pushed a troubling point far enough, but let me add Ossa on Pelion—two cheering statistics. In this century the world has used up, and has lost forever, more natural resources than has all previous history. And there are now alive, with an unprecedented appetite for resources, 10 per cent of all the men who ever lived on this earth. Twenty-five billion people in the long million years since the dawn of man. Two and a half billion since Yellowstone National Park was created, people using up more resources, including space, than all the rest, and at greater speed. Yes, using up all the resources available to mankind except the resource of restraint.

While the ushers pass out the sackcloth and ashes, contemplate these figures. But please don't take time to check my arithmetic. It comes from a good source, but the accuracy of the source doesn't really matter. Time is running out. Whatever the time left, we can do better with it than we are doing. I agree with Allen Morgan, who says about wild open spaces that "what we save in the next few years is all that will ever be saved."

The important opportunity is to accept the fact that we are confronted with a problem the likes of which our predecessors hardly dreamed of, that it is a problem that man created and that men can solve—but not by reaching for a tranquilizer and curling up with the slick magazine that reassures us, with charts and diagrams in three colors, that science will save us; science, unaided by people.

* * * *

If you feel the need, about now, for a draft of fresh air, be assured that I do too, and that is what I'm here to talk about. About wildness—and wilderness, where the best of wildness lives. Wilderness is fairly close to the best place of all in which to find a draft of fresh air, in which to take stock, in which to find yourself, discover the *you* that so many distractions have kept you away from so long that the life you lead is not your own.

What about wilderness? What is it, where is how much of it? For whom and why? And if so, how can we keep some for a still more crowded world than ours, a world that will probably need the raw materials of wilderness more than we think we do, and that will need the spiritual resources ever so much more than we do?

We could easily devote an hour's discussion to each of these questions. But let me assure any of you who is tempted to rush for the exit that I shall limit myself instead to no more than a few minutes' musing on all the questions put together.

But first, a definition of wilderness is in order.

Mrs. Malaprop might have said that wilderness is a place where the hand of man has not set foot. But she didn't. She had not heard of the kind of wilderness, as a concept, that we are talking about. Not that it's exactly a new concept. The prophet Isaiah seems to have had it in mind when he wrote what was translated as "Woe unto them that join house to house, that lay field to field, till there be no place, that they may be placed alone in the midst of the earth!"

Moses found opportunity for his people in wilderness—wilderness much of which was turned to desert before the Sermon on the Mount admonished man to consider the lilies of the field—the natural field I assume—and how they were arrayed. That wilderness was subsequently utterly stripped of its verdure by man, including the exploitation of the Cedars of Lebanon, which went down to the sea in ships.

To compress the history of wilderness into a few lines: The Middle Ages, and nothing. Then the Renaissance, and Conrad Gesner finding reason for the admiration of mountains. Then very little until William Blake worried about those dark Satanic mills. More recently Olmsted, Emerson, Thoreau, and Muir. Finally the explosion of man across the earth, and here, in the United States, wilderness vanishing with such velocity that we knew, inescapably, that man alone was responsible for the loss. The 1920's and the Forest Service trying hard, under the leadership of Aldo Leopold and Robert Marshall, to define wilderness in terms of what should *not* happen in wilderness. In 1930 Robert Marshall defining it in terms of what man *should* find in wilderness, ought to find, had to find if the spirit that has stood him upright was not to perish in an overcivilized lukewarm world.

Marshall used the word wilderness "to denote a region which contains no permanent inhabitants, possesses no possibility of conveyance by mechanical means, and is sufficiently spacious that a person crossing it must have the experience of sleeping out." Survival in it, he said, is up to you. Find environment *in* it; don't bring one with you.

This idea of wilderness, new though it is, is now quite widely accepted. It isn't yet underwritten by federal law, but it does appear, strangely, in an international treaty on nature protection and wildlife preservation in the Western Hemisphere which was signed by the United States 18 years ago. In this treaty wilderness is defined as "a region under public control characterized by primitive conditions of flora, fauna, transportation, and habitation wherein there is no provision for the passage of motorized transportation and all commercial developments are excluded."

Let me add one more definition and then move on. This one comes from the Wilderness Bill: "A wilderness, in contrast with those areas where man and his own works dominate the landscape, is hereby recognized as an area where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain."

* * * *

This is a lot of detail about definition. Why? Because when someone is about to be tempted to cash in on a priceless heirloom rather than work a little harder for the money instead, it is high time that he look hard at that heirloom, find out what it means to him, whether he should let it slip away or pass it on to his son instead, as it was passed on to him.

My analogy isn't very good, for wilderness goes far beyond being a mere heirloom. There is no sentimentality about wilderness.

As Howard Zahniser, of The Wilderness Society, has put it: "We work for wilderness preservation not primarily for the right of a minority to have the kind of fun it prefers, but rather to ensure for everyone the perpetuation of areas where human enjoyment and the apprehension of the interrelations of the whole community of life are possible, and to preserve for all the freedom of choosing to know the primeval if they so wish."

And we work hard, with a sense of urgency. The wilderness we now have is all the wilderness we shall ever have in America. There is little left—less than one-third acre per person in the United States if you count all the wilderness that has any administrative protection in our national parks and forests and wildlife refuges and on Indian lands. One-third acre per person today; less per person as our population expands still further; all of it subject to being struck out by an administrator's pen.

So wilderness can no longer be abundant enough for every man to walk on it. But after all, only the small child must handle a thing to know it; adults need only look. Those in between need a little of both. So some people will be able to walk on it and most of them will be the better for it. Some may wish to but never make it—especially when the bulk of our wilderness is as far to the west as it is from you. Some people may not care to go there at all. But their sons may wish to. And wilderness must be there or the world's a cage.

I say all this about wilderness because it is the essence of the wilds we need around us. Since it lives but once, there should be ample opportunity to review the death sentence that so many people in the chambers of commercialism would like to inflict upon wilderness.

Many of us feel that wilderness should have an automatic stay of execution, and that Congress should provide it.

Hence the Wilderness Bill—the proposal to establish a National Wilderness Preservation System.

* * * *

Reintroduction of the remarkable Wildnerness Bill in the 86th Congress is an occasion for looking at the hurdles which many interests are hurriedly trying to place in front of it—almost all of them apparently manufactured at the same source. Here is a look through the eyes of an observer who believes this legislation to be of vital importance.

Several months ago *The New York Times* commented editorially that the bill was running into opposition that its mild terms did not deserve. The revised bill is, if anything, milder still; the opposition more vociferous.

A recurrent allegation is that wilderness is only for the selfish, rugged, single-interest minority. Wilderness advocates may well reply that the black pot is seeing its own black reflection in a shiny kettle; for the allegation comes from a series of single-interest groups—lumber, mining, oil, cattle, sheep, and road-and-dam building interests—who dislike barriers to what they may hope to develop for their own single use in the remaining fragment of wilderness.

There is a recurrent attempt, also, to depict the proposed Wilderness Council as a monster, and then to be frightened by the creature so depicted. A "built-in lobby," with amateurs "in the management saddle"—thus one group describes a body that would consist of the Secretary of the Smithsonian, the Secretaries of Agriculture and Interior (or their representatives), and three citizens appointed by the President and confirmed by the Senate, and known to be informed about wilderness and interested in its preservation. The Council could collect and disseminate information and make recommendations, but would have no administrative authority. It would probably provide a better public presentation of facts about the meaning of wilderness than "frightened" opponents of the bill seem to wish the public to have.

In short, opponents are attributing monstrous powers to a Council which has no powers, but would merely try to keep a horizontal route open across the vertical channels of the bureaus concerned. Finally, they attempt to assign the consideration of permanent protection of wilderness to a temporary group (the National Outdoor Recreation

Resources Review Commission) that was not created to protect anything, but rather to study and recommend.

Let me clarify this point if I can. Supporters of wilderness protection welcome all the attention the Outdoor Recreation Review Commission can give to the subject. They do not, however, want to see the Commission used as a device for delaying protection which is needed now.

There has already been a decade of careful study leading up to the present Wilderness Bill. There is immediate need for what William H. Whyte, Jr., calls "retroactive planning"—for protecting *now* the land we think is needed, then rationalizing later how right we were all along to have done it. If too much wilderness is protected this way, we can always correct the situation later. If too little is protected, if too much has been turned over to exploitation, then we cannot unfry the egg.

The Commission was never conceived of, by its originators, as a device to delay protection, but rather as a way to defer destruction, and to find an equitable basis for halting that which studies should demonstrate to be needless. We knew that the scenic resources—wildlife, wilderness, parks, and the outdoor recreation deriving from them—were getting short shrift. Millions upon millions of dollars were available for planning the nation's future commodity programs, next to nothing for recreation. It was time to start balancing this; hence the Outdoor Recreation Resources Review Commission.

Wilderness protection must not be delayed. If you will remember your first aid course, you will remember these priorities: breathing, bleeding, shock. It does little good, if a patient is bleeding to death, to sit down and study objectively what kind of bandage will be needed on the wound. You get in there and stop the bleeding. Otherwise you'll have nothing to bandage but a corpse.

The best way to help the Commission in its study is to keep some living wilderness for it to count upon. The Wilderness Bill can check the bleeding.

For all the opposition furore, there is an amazing body of public opinion supporting the Wilderness Bill and its provision for an automatic Congressional stay of execution of moves to obliterate designated wilderness. That opinion was represented in a eight-to-one ratio of letters sent to the Senate Interior Committee for inclusion in the record of last fall's field hearings on the bill.

Support comes from no hastily organized battalion of rugged hikers, no "wilderness lobby"; it reflects broad public concern about direction. It reflects growing conviction that "the nation does not exist to serve its economy"; that there must be more public participation in the treatment of the single heritage of land that must serve all the generations (hence the added role for Congress in wilderness protection and military withdrawals), and that to "leave these things to the experts" is to resort to absentee citizenship.

It also reflects the dawning realization that Growth without end is soon monstrous, then malignant, and finally, lethal—that an economy based upon incessant growth may well turn out, in the long run, to have been a chain-letter economy, in which we pick up the handsome early returns, and either our children or theirs find the mailbox empty, their resources having been expended by us.

I was trying to make this point in Berkeley a short time ago and a question came up from the floor: Could we afford to do anything less than keep growing inasmuch as that was what the Russians were doing? While I struggled ineptly with a reply a conservationist-chemist came to my rescue. "You've heard of the game of 'chicken,' haven't you?" he asked. It's sort of a Russian roulette on wheels. Two juveniles head directly toward each other at high speed on the highway, and the first one who turns to avert the crash is chicken. We frown on such behavior in adolescents, but we seem to accept it as national policy."

Supporters of wilderness—and of the restraint that is inherent in preserving it—also like civilization. They like it well enough not to want it to take too many steps, with "the bland leading the bland," down the road paved with good inventions, on which there may be no turning.

Whoever should look for the words, "Wilderness Lobby" on the door of some office near Capitol Hill would be looking in the wrong direction. He should look instead at the land—all the land the country is ever going to have for all the U. S. citizens ever to be born—and the rapidity with which many of its nonrenewable resources have been used up for so few. (He should resist reiterating "Science will save us" until he has counted the ever-more-perplex problems the "saving" has already brought us.) And he should look at a few recent books that cannot be isolated from a common concern about an uncommon threat to civilzation: Brown's *The Challenge of Man's Future;* Galbraith's *The Affluent Society;* Packard's *Hidden Persuaders;* Whyte's *The Organization Man* and *The Exploding Metropolis;* Keats's *The Insolent Chariots;* Huxley's *Brave New World Revisited;* Gary's *The Roots of Haven;* Callison's *American Natural Resources;* and Leopold's *A Sand County Almanac.* The list ends too soon and is almost humorously disparate. Yet it has a common denominator of substantial uneasiness about what we are letting happen to us, about things that are forcing us into a corner where we must choose to live with less or not at all, witnessing instead, in that last blinding flash, the final glimpse of struggle between economics seeking to out-exploit one another.

The connection between the ability of civilization to protect wildness and the ability for civilization to survive is not so tenuous as we might wish. It is worth energetic scrutiny, and at length. For the kind of thinking that motivates the grab for what's left on the bottom of the barrel—the pitiful fragment of resources in the remaining wilderness—is the kind of thinking that has lost this country friends it cannot afford to lose. The ultimate in selfishness is evidenced in those opponents of wilderness preservation who have demanded an open door for exploiting wilderness while they slam another door in the face of friends needed overseas and north of the border. Don't import oil, wool, plywood, lead, zinc, the opponents say, whatever such restriction may do to the economy of our friends. Don't import them because we have more than enough of our own. And concurrently opponents urge that nothing interfere with their looking for still more of their own—anywhere in the public's dedicated wilderness!

The international economic and political difficulties the wilderness opponents would thus aggravate are serious. The difficulties may not stem from their opposition to wilderness, but there is certainly guilt by association. They stem from what could be called a philosophy of last things first.

It has remained for a physicist to single out the biological peril. As Dr. J. A. Rush put it: "When man obliterates wilderness, he repudiates the evolutionary force that put him on this planet. In a deeply terrifying sense, man is on his own."

As a handy example, I have beside me in my hand a small object, about the size of the letter *o*, which the evolutionary force has built. Within it is embodied a direct living connection all the way back through all the aeons to the very first appearance of life on this planet. Against that space of time man's life span is insignificant, his ken is barely significant, the entire duration of mankind is hardly noticeable. The object, of course, is a seed. Packed in a fragment of its space is all the know-how needed to perpetuate redwoods on earth, even if every other seed and existing redwood were to be wiped out. Included in that know-how is the ability, should a once-in-a-century flood bury the base of the mature tree in silt, to activate the pushing of new roots—out through bark two feet thick, and out at just the right level below the new surface of soil in which the tree now stands.

I know of no research to determine in just what gene area this particular know-how exists, or what its biochemical formula is. Fortunately, no scientist has to know this. But the tree has to know it to survive, and it *does* know it. Man did not have to steady the Teacher's hand when it found out, or when all the other forms of life found out how to perpetuate themselves, through good times and bad, in the wilderness they are designed to live in together, in equilibrium.

Does man dare be so arrogant as to assume that he must take it upon himself to steady the omnipotent force, throughout the land, even to the last two per cent of wilderness? Perhaps Dr. Rush had some question like this in mind when he spoke of wilderness, the evolutionary force, and the terrifying prospect if man tries to stay on this planet without it. And Thoreau, too, when he wrote: "In wildness is the preservation of the world."

The Wilderness Bill is a needed step toward the recognition of this truth. Not just any bill, but a strong one, recognizing as national policy that wilderness is where you find it and keep it. There is little left to find, and scant little time remaining in which to resolve to keep some of that little—to rescue it from the raw materialism which threatens not only wilderness, but survival too.

PART II

TECHNICAL SESSIONS

TECHNICAL SESSIONS

Monday Afternoon—March 2

Chairman: George C. Decker
Head, Section of Economic Entomology, Illinois Natural History Survey, Urbana, Illinois

Discussion Leader: F. S. Arant
Head, Department of Zoology and Entomology, Alabama Polytechnic Institute, Auburn, Alabama

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PESTICIDES AND CONTROLS

PEST CONTROL IN THE MODERN SETTING

Harlow B. Mills
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In a problem which has been as volatile as the present one, if an objective, unbiased stand is attempted, one is likely to find himself in a small, select and lonely band. There is an electrolytic process which draws good people to the anode or the cathode almost against their wills.

If one attempts to find common denominators, he is likely to be accused of mouthing frothy old platitudes. I take that chance today. Most "causes" remind me of Captain Ahab's boat, the *Pequod,* in Moby Dick. Concerning it, Herman Melville said, "Top-heavy was the ship as a dinnerless student with all Aristotle in his head." I am neither hungry nor full of the old Greek natural philosopher, so follow now the platitudes.

The dramatic and tremendous increase in human populations is bringing in its wake a great many problems. The needs which people have, and the values which they place on objects or activities, are becoming more complex by the moment.

One reads in the Bible that man cannot live by bread alone. He can't and remain human. The future need which otherwise peaceful people will have for food is going to be tremendous, and will tax our technological ingenuity, but man also needs something beyond this.

All people are blessed with an esthetic sense, whether all will admit it or not. And this interest in the curious, the exciting, the adventurous, the beautiful is as much a part of a person as is his anatomy.

Because of this bipartite character of mankind, conflicts of interest and differences in values are bound to arise, and we are likely to have different ideas concerning the use or misuse of natural resources. As wildlife need food and protection to best carry out their economies, so does mankind. But mankind must have that little bit more. And in the race for food and protection, and the extra leavening of human living, there is always the possibility that in striving for these things for ourselves we may diminish the needs of wildlife. Actually, if man were not endowed with such attributes as appreciation, curiosity, and a moral conviction which accompanies his ability to conquer and destroy, there would be few crossings of purpose in our interest in natural resources.

While we may be striving for the same general goals, the problem of what weight we give to values must be faced. You will recall the large number of deer which were killed in California in the control of hoof and mouth disease. I have a friend in the field of public health who told me once, "I can make a good case for the destruction of large numbers of our birds, for they are carriers of human encephalitis." Such decisions are constantly before us. They are today in our concern over the use of pesticides.

There is an old belief that, "Because a thing is new it is dangerous." The unknown has always been feared, but as the unknown gradually emerged from its limbo and became the understood, our fears dissipated, or were localized. In the face of unknowns it becomes difficult to weigh values with objectivity.

Problems relating to the unknown or little known are compounded by erroneous extrapolation. We may say that, because a certain pesticide when properly used has been shown to be innocuous to livestock, it is equally without danger to wildlife. In a paper given by Dr. Decker at the meeting of the Ecological Society of America in August, 1958, this view is attacked. Dr. Decker states, ". . . whereas man and his domestic animals are afforded much protection by . . . definite time lapse intervals between insecticide applications and the harvest or consumption of a crop, it is generally recognized that most forms of wildlife can hardly be expected to avail themselves of such precautions." He points out further that wildlife may be subject to hazards not affecting man or his domestic stock. Smaller animals ingest more food per unit weight than do large animals. While domestic stock may be affected only orally, wildlife may be subjected to poison from ingestion, absorption, or inhalation. Lastly, he states that small animals move in, around, and under vegetation, and are subject to greater and more prolonged exposures than are the larger domestic animals which stand well above the treated vegetation.

These arguments should dispel the desire on the part of some pesticide users to make broad, sweeping generalizations on the safe use of pesticidal chemicals in wildlife habitats. But we might enforce our belief in the dangers of extrapolation with one more example.

The very important studies of Dr. DeWitt on the effects of chronic poisoning on game birds shows that when these birds are fed sublethal dosages of various pesticidal chemicals for a period of time, hatchability of the eggs, viability of the young, and general reproductive ability are impaired. This is important information, obtained in a thoroughly scientific manner, and subject to our careful consideration. But there is a tendency on the part of some people to extrapolate this danger into nature with insufficient basis. Birds in nature are not generally subjected to the rigorous conditions of DeWitt's experiments. They have choice in food, there is a gradual reduction in availability of the poison to them as time goes on, and whether under conditions of application now used these wild birds will ever get enough of a chronic dosage to produce impairment of the reproductive capacity is completely unproven, and could well not be a factor in the well-being of wild populations.

We, as wildlife people, have seen the cloud of possible injury to wildlife populations on the horizon for at least 13 years. But what have we done to get fundamental data? Very little which was not of a fortuitous nature, where the datum taking was easy, or the effect of the poison dramatic. It would not take long to count the titles of quiet, reasoned experimentation such as that of DeWitt mentioned above, Barker's work on earthworms and robins, or Fashingbauer, Hodson, and Marshall's study on the interrelationships of a forest tent caterpillar outbreak, song birds, and DDT. We are away behind in developing this type of scientific competence, and we can't blame the pest control people for that.

What do we know about the difference between toxicity and hazard? Do we confuse these two very different things? As was implied above in the comments on extrapolating from concise pen experiments to conditions in nature, there is a great difference between the actual poisoning ability of a chemical and the chance that it will act on an organism. Here again we are subject to the dangers inherent in transferring one set of data into different conditions from those pertaining where the data were obtained. The most dangerous poison in the world is completely innocuous if it is not in a position to be injurious to some organism. When a poison is applied there may be all shades of hazard to wildlife, and these shades too many of us are not willing or able to discriminate.

What is the effect of a drastic initial kill on the wildlife populations over a period of time? What conditions govern repopulation of an area? Is a complete depopulation of an area a significant thing in the light of the values being protected by pesticidal application? There are several factors which may affect repopulation of an area, among which we could mention

1. Size of the area depopulated.
2. Shape of the area depopulated.
3. Availability of an invading population.
4. Mobility of an invading population.
5. Persistence of action of a depopulating agency on immigrants.
6. Effect of a depopulating agency on specific food or cover items needed by immigrants.

The relationships of these factors to potential repopulating species must be known before we can clearly understand the significance of losses. A little work we have done at the Illinois Natural History Survey, soon to be published, will bear on this matter. There are two kinds of data, those on the effect of dieldrin on terrestrial wildlife species and the repopulation of areas, and those on the repopulation of a stream after it had ceased to run and the pools had been treated with rotenone. These kinds of data are precious as uranium now, and as rare.

A few things we can now say about depopulation of an area and be relatively safe. It can be extremely bad; the wildlife values can go up tremendously, if depopulation affects exceptionally restricted species such as fulvous tree ducks on the Gulf coast, woodcocks in Louisiana, or Everglade kites in Florida. The values go up if the depopulated species is rare but not restricted especially in its distribution. The values go up if but one stage in the life cycle of desired wildlife species is greatly injured.

To bring this discussion toward its completion, what are the responsibilities of wildlife people in pest control operations?

Wildlife people should study and objectively classify the different segments of pest control problems as to their danger to wildlife in the light of the other values which such programs are supposed to protect or enhance. This will give users of pesticides a sound basis for recommending changes in control measures, or places where these measures can be modified, rather than placing us in the difficult situation of suffering critcisms based on too much extrapolation. They will have to recognize the right of agriculturists to protect their property in any reasonable and economic way. The prime responsibility of wildlife people is in relation to wildlife, and not necessarily in relation to the merits or demerits of a program of pest control or the possible deleterious effect of such control on other than wildlife values.

Out of the fog which now pervades this broad problem a few generalizations begin to shape up for me. *First,* we are facing a new era in which pest control chemicals, be they rodenticides, herbicides, fungicides, or insecticides, are going to be more and more a part of the environment, and this move is not immediately or greatly reversible. *Second,* these chemicals *will* change the environment some, just as did the plow and drainage shovel a few generations ago. This situation will be with us as long as people increase in numbers and needs and fastidiousness. *Third,* the use of pesticides must be made as innocuous as possible, recognizing that injury will occur to wildlife at some times and in some places. Lastly, we now have too few data to intelligently recommend many modifications in pest control activities, except for a completely negative approach which is not the most effective way of approaching any problem.

This past winter I read Elton's new *Ecology of Invasions* in the hope that this book would yield some practical ideas of immediate application. The main impression which I gained from this interesting book was that we are far from the desirable goal of ecological control of pests. There is a tremendous literature in the field of ecology available to us at the present time. Perhaps what we need most now is a Darwin for ecology, who can painstakingly sift the literature and develop generalizations which will help us to live with pests, the depredations of which would be kept to a minimum by the interplay of species and habitat. Thus far no such Darwin has appeared, but he is badly needed.

DISCUSSION

MR. CLAUDE D. KELLEY [Alabama; President of the National Wildlife Federation]: Dr. Mills stated that there was no way to justify claims that birds and mammals in the wild that had received a sublethal dose would be affected as to productivity.

I want to know if the evidence which has been presented showing large-scale kills of wildlife does not indicate that many of those that weren't killed had carried a high sublethal dose that would in all probability have some effect on their reproduction.

DR. MILLS: Well, Mr. Kelley, I didn't say that there was no way of finding out. There are ways of finding out, but it is going to take time to do it. We may in the course of time have good information on it.

We don't know at the present time, for example, whether one shot which would be a sublethal dose would have the same effect that was noted in birds at Patuxent, where they were given major dosages over a period of time. That is, these things are in the realm of the unknown as yet, but, I surely hope that by this time next year at least part of it is going to be in the realm of the known. I don't think we have enough information now to know. What is it going to do to the reproductive ability of a bird if it gets a one-shot dose which it gradually loses? I don't know.

DISCUSSION LEADER ARANT: I might make one comment on this particular problem, Dr. Mills. In one experimental area in Alabama where dieldrin and heptachlor were applied, bobwhite quail were eliminated from the central part of this area about a year ago. The quail have migrated back in from surrounding areas. The area is being repopulated. There was evidence early in the year that there was no reproduction in the area. However, later in the summer there was reproduction and young quail are now on that area, which was treated about one year ago.

DR. CLARENCE COTTAM [Welder Wildlife Foundation, Texas]: I want to compliment Dr. Mills on that scholarly paper. I have no criticism of it. There are just two points, however, that I think could be commented on just a little, and one is this: that it should be—it isn't unreasonable, it seems to me—that those who are carrying on controls keep the losses to the minimum even though there may be some damage—and we expect some damage—but I think that ought to be emphasized. There is a responsibility that an agency that is carrying on controls should carry them out with the least damage rather than with the most damage, and I don't believe that has been emphasized quite enough.

One other thing: his comment, and it is hard to take exception to it, that oftentimes the unknown frightens us terribly; when things come to light they are not nearly so bad as we might have thought they might be. I am wondering if we were in the course of a battle, if a commander would take a risk like that. I think we had better count on this, that these things might be damaging, and hope to the good Lord that it won't be as bad as it might be. I think that would be a safer means of survival than to assume that it is going to be a dam site better than it could be.

ACCUMULATION AND DISSIPATION OF PESTICIDE RESIDUES IN SOIL

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In controlling agricultural pests with chemicals, it is necessary to accept the fact that pesticides come in contact with the soil and may leave accumulating residues. This is true of chemicals used to control insects, diseases, weeds, and other crop pests. This paper is limited to a discussion of some of the common chlorinated hydrocarbon insecticides and their accumulation in and dissipation from soils of treated areas.

A portion of any insecticide dusted or sprayed on crops falls di-

[1]In the absence of the authors, this paper was read by Dr. H. L. Haller.

rectly on the ground or is later washed or blown from the plants. Frequently, insecticides are mixed with the soil or applied to turf to control soil-inhabiting insects. These chemicals are for the most part organic compounds such as DDT and other chlorinated hydrocarbons.

The quantity of a chlorinated hydrocarbon deposited on the ground is limited by many factors. These include type of formulation and the percentage composition of the insecticide, method, rate, and frequency of application; and density of foliage. Substantially, all of granular formulations are deposited on the ground. A smaller proportion of high-volume dilute sprays, such as those applied by guns in orchards, drips from the leaves as excess spray. Dusts do not adhere to foliage as well as sprays and may be dislodged by wind or rain soon after application. Very small proportions of highly concentrated sprays, such as those applied by airplane for spruce budworm or gypsy moth control, for example—are deposited on the ground in forests. Some insect control programs, such as those for cotton insects, may require seven or more applications involving ten or more pounds of DDT during a single season. Often a spray program may require the use of several different insecticides during the season. On the other hand, a year or more may elapse between sprayings of forests at the rate of one pound of insecticide per acre.

Deposits of chlorinated hydrocarbons remain exposed to prevailing weather conditions for various periods, ranging from long periods on the ground cover of forests or on turf to extremely short periods on field crops that may be cultivated soon after treatment.

The temperature of the ground surface may be much higher than that of the air in which case dissipation of the insecticide deposit is speeded up. In a field of grain sorghum in Texas (Randolph *et al.*, 1956), a surface temperature of 149°F. was recorded when the air temperature 6 feet above the ground was only 113°F. Records taken in forests (Vaartaja, 1954) showed that surface temperature exceeded air temperature by 50°F.

Studies with aldrin, DDT, dieldrin, and lindane (Barlow and Hadaway, 1955) indicate that when these chemicals are applied on soil blocks, a portion of the material vaporizes, is sorbed by the soil, and becomes inactive as an insecticide. The rate of sorption depends on the type of soil; muck or clay soils take up the vapor more rapidly than sandy soils do.

The depth to which chlorinated hydrocarbons are distributed in the soil depends largely, of course, on the depth of cultivation. Field plots (Allen *et al.*, 1954) were treated in 1947 with 100 pounds of DDT per acre and sampled four years later in 2-inch layers to a depth of 10 inches. Ninety-seven percent of the DDT remaining (32.5 lbs.

per acre) was found in the top 8 inches of soil, the approximate depth of plowing. Similar results (Kincaid *et al.*, unpublished) were obtained in 1956, when soil samples to a depth of 12 inches were taken from 15 commercial tobacco fields in which chlorinated hydrocarbons had been applied each season for about 10 years. One year after turf plots (Chisholm and Koblitsky, 1952) were treated with 25 pounds of DDT per acre, 92 percent of the amount remaining (18 lbs. per acre) was in the top inch of soil and the other 8 percent in the next two inches of soil.

The term "accumulation" may suggest that residue concentrations in soil continue to increase indefinitely. Actually, there may be little or no accumulation from year to year. In range plots (Carter *et al.*, unpublished) sprayed with aldrin, heptachlor, and toxaphene in 1958, for grasshopper control, about one-half of the amounts applied were found in the soil one day after spraying. After 42 days, no heptachlor or heptachlor epoxide could be found. And after eighty-four days, only 8 percent of the aldrin and 4 percent of the toxaphene could be found.

In other tests (Allen *et al.*, unpublished) 10 applications per year of aldrin, BHC, chlordane, dieldrin, endrin, heptachlor, isodrin, and toxaphene were made to cotton rotated with tobacco. After three successive rotations the residues of aldrin, BHC, dieldrin, and heptachlor in the top 6 inches of soil averaged less than 1 pound per acre (roughly 0.5 parts per million). Those of chlordane and endrin averaged 1.3 pounds and that of toxaphene averaged 12.4 pounds. Analyses were made (Kincaid *et al.*, unpublished) on soils taken to a depth of 6 inches from commercial tobacco fields during a 5-year period. About half of the fields were rotated with corn or another alternate crop. Following 39 tobacco crops the average increase of residue from the preceding year was equivalent to 4.8 pounds of DDT per acre. Following 31 alternate crops the averaged residues had decreased by 2.7 pounds per acre. In some of the rotated fields there had been little or no increase during the 5-year period.

The accumulation of chlorinated hydrocarbons in soil is highly variable among crops on which they are applied. After high-volume sprays had been applied during seven seasons to apple trees in New Jersey (Ginsburg, 1955), DDT residues ranged from 19 to 45 parts per million in the top 6 inches of soil under the trees and from 11 to 27 p.p.m. between the trees. Potato fields in the same state had been cropped annually for eight years and sprayed seven or eight times each year with DDT at the rate of 1 pound per 100 gallons of spray. Residues ranging from 1.1 to 1.8 p.p.m. were found in the top 9 inches of soil.

Chlorinated hydrocarbons do not persist indefinitely after being mixed with soil or applied to turf to control soil insect pests. They dissipate, however, at various rates. Several chemicals were mixed with soil in plots located in Maryland, Mississippi, New Jersey, and Washington (Foster *et al.,* 1956). After four years, it was found that aldrin, chlordane, heptachlor, and lindane were much less persistent than DDT, dieldrin, and toxaphene.

These and other tests (Boswell *et al.,* 1955) also show that the rates of dissipation vary among locations as well as among the insecticides.

In Texas (Randolph *et al.,* unpublished), BHC, DDT, dieldrin, and toxaphene, in amounts equal to the totals applied to cotton during five years were mixed with the soil. During each of the next three years, the amounts normally applied in one season were added to the soil. At the end of this 3-year period, the averaged amounts of DDT, dieldrin, and toxaphene ranged from 14 to 18 percent of the total amounts applied. BHC averaged 2.5 percent.

Studies have also been made of the persistence of aldrin, chlordane, DDT, dieldrin, TDE, and toxaphene applied to established turf in northeastern United States (Fleming *et al.,* 1951; and Fleming and Maines, 1954). Aldrin and chlordane were less persistent than the others. For example, where 10 pounds of chlordane had been applied per acre, 1 pound was determined by chemical analysis and 0.5 pound by bioassay 5½ years later. Where 25.5 pounds of DDT per acre had been applied, 7.0 pounds were determined by both chemical analysis and bioassay 6 years later.

Volatilization and erosion, according to studies thus far, are the main causes of dissipation of chlorinated hydrocarbons in soil. Volatilization is probably the principal cause. Despite the fact that all of these chemicals have low vapor pressures, studies indicate that over periods of months or years large proportions may be converted to vapor and escape into the atmosphere, especially by co-distillation with the water vapor escaping from the soil (Bowman, Acree, Schmidt and Beroza, unpublished).

Pesticides mixed with soil may be removed from treated areas by water erosion. However, if the residue is on the surface of bare ground, all of it may be carried away by erosion. From forests having dense ground cover, only a small proportion of the pesticide residue could be expected to be washed away. Since residue concentrations in soils are at low levels, extremely large amounts of contaminated soil would have to be eroded in order to produce appreciable concentrations of insecticides in streams. For example, a soil may contain 1 pound of pesticide distributed to a depth of 6 inches (0.5 p.p.m.). To produce a concentration of 0.025 p.p.m. in a stream, the water would have to contain 50,000 parts per million of suspended soil. Very muddy water contains 100 to 300 parts per million of solids. The chances are small, therefore, that dissipation of insecticides from soil through water erosion constitutes a hazard to aquatic life.

In conclusion, we want to stress that research workers are aware of the concern regarding possible harmful pesticide residues in the soil. We believe the only way to reach sound decisions regarding their use is through carefully planned and executed research. Investigations to date indicate that chlorinated hydrocarbons do not remain indefinitely in the soil.

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DISCUSSION

MRS. THOMAS WALLER: [New York; Conservation Chairman, The Garden Clubs of America]: I believe Dr. Chisholm stated that small amounts of DDT obviously will fall upon the ground if we are using a mass spraying program, even at one pound to the acre—and I presume you would feel that that was probably not harmful if you are using it in that small quantity. Is that correct?

DR. HALLER: That is my view and I believe that is Dr. Chisholm's view.

MRS. WALLER: That is what I gathered. I happen to be a farmer. We have a herd of pure-bred Guernsey cows. In the spring of 1957 our farm was sprayed in the process of spraying Westchester County with one pound of DDT, oil based, in an endeavor to control the spread of the gypsy moth. We do not have the gypsy moth in Westchester County. This was simply a control program. We were not in the direct line of fire. The spray that came over our property was more drift spray than a direct spray. We had milk from our cows tested two days before this spraying was done, and our milk was tested 48 hours after spraying. The chlorinated hydrocarbon content of the milk 48 hours before spraying was zero. Forty-eight hours after, it was 14 parts per million in spite of the fact that, as you know, the Department of Health does not permit any chlorinated hydrocarbons in milk which is sold to the public, which our milk is.

Now, along with that, I would like to remind you that in the directions which the U. S. Department of Agriculture, in the State of Alabama, gives to landowners when their property is to be sprayed to eradicate the fire ant, using dieldrin and heptachlor, this paragraph appears:

"Cattlemen and dairymen should keep their cattle off treated pastures for the following periods of time: milk cows, 30 days; beef cattle, 15 days."

Now, as a farmer, I don't know how they expect us to keep our cattle off for 30 days. You just can't do that.

DR. HALLER: I think the speech speaks for itself.

DISCUSSION LEADER ARANT: One question that occurs to me has to do with the co-distillation of DDT with water from the soil. Would you comment on that, Dr. Haller?

DR. HALLER: I don't want to give a dissertation on physical chemistry, but when you mix chemicals that are substantially insoluble in water with hot water and ultimately boil that water, which becomes steam, a small amount of the chemical, regardless of its solubility, boiling point, or melting point, is carried along with the steam vapor and in that way distills off. That is what we mean by a co-distillation process. In chemistry it is spoken of as a "steam distillation of an insoluble chemical" and it looks as though far more is carried away from the soil than is generally appreciated. Some of our studies indicate that soil temperatures in general are much higher than is generally realized, as indicated by the two data I presented there.

INSECTICIDE RESIDUES AS HAZARDS TO WARM-BLOODED ANIMALS

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During the past few years, as a result of concern that the widespread use of insecticides might be creating a public health problem, several scientific bodies undertook a factual study of the problem. The World Health Organization (1953 and 1956), the U. S. Public Health Service (1954), and the Food Protection Committee of the National Research Council (1951 and 1956) formulated the following conclusions: (a) The large-scale usage of pesticides in the manner recommended by manufacturers or competent authorities and consistent with the rules and regulations promulgated under existing laws would not be inconsistent with sound public health programs, and (b) although the careless or unauthorized use of pesticidal chemicals might pose potential hazards requiring further consideration and study, there was no cause for alarm.

These encouraging conclusions notwithstanding, the very fact that insecticides may, and no doubt will, be misused still remains a matter of some concern to a considerable segment of the American public. This is true particularly of conservationists and wildlife enthusiasts who quite correctly insist that many forms of wildlife are subjected to certain potential hazards not shared by man and his domestic animals. This point should be impressed on all entomologists, toxicologists, and wildlife biologists alike. First of all, smaller animals generally ingest more food per unit of body weight than do larger animals. Consequently, if a food becomes contaminated by an insecticide, it follows that small animals will ingest proportionately larger dosages than would larger animals feeding on the same food. It is also obvious that smaller animals moving about, in, and under treated vegetation are subjected to greater exposure than are larger domestic animals standing well above the vegetation. Exposure of smaller animals may result in three possible methods of intake; that is, by ingestion, by inhalation, and absorption through the skin. Larger animals, on the other hand, may be subjected primarily to only one route of entry.

It is not surprising, then, that numerous cases have been reported where wildlife has been adversely affected by insecticides. Most of the time, however, such incidents can be traced to carelessness, to accidents, or to outright experimentation. The fault in practically all cases must be laid at the feet of the applicator. Considering the thousands of tons of insecticides which have been used and misused in the last 50 years, the impact of insecticide usage on wildlife has not been great and certainly has not been disastrous. Actually, it has been insignificant when compared with many of the other everyday acts of man.

Anyone who is at all familiar with the excellent reviews on wildlife-insecticide relationships by Brown (1951), Rudd and Genelly (1956), and Cope and Springer (1958) must be aware that there has been a considerable volume of both laboratory and field research, much of which tends to pinpoint areas of considerable concern which are in need of further research. Nevertheless, at times one finds it difficult to evaluate many of the criticisms directed against insecticides and certain insect control practices. Some authors have noted that certain insecticides (for example aldrin and DDT) have been used at dosages which are actually 10 to 20 times the normal dosage and would lead one to believe that this is the rule rather than the exception. Actually, the vast majority of uses for aldrin stipulate applications of 4 to 8 ounces per acre while DDT is generally used at rates between 1 and 2 pounds. Quite simply, it is generally economically impractical and highly unnecessary from an insect control standpoint to use them at greater rates.

Other authors note that aldrin and heptachlor are 5, 10, or 20 times as toxic as DDT, and then matter-of-factly imply that the residues may persist for several years and that the hazards involved are tremendous. All too often it is not indicated that these materials, compared to DDT, are very short-lived and are normally applied at low rates of application. In as little as a few hours after treatment, residues are apt to have diminished to quantities incapable of the further killing of insects, much less larger, warm-blooded animals. Unless an animal is in the area at the time of treatment and unless the dosage rate is considerably in excess of normally recommended applications, its chances of survival may be greater where the more toxic chemical is used. Even DDT, which we think of as being the most persistent of the insecticides in common usage, is less persistent on plant and soil surfaces and is considerably less toxic to warm-bloods than were the arsenicals, commonly used before the introduction of DDT.

Such criticisms as have just been mentioned are just as incorrect and as ethically wrong as those of certain entomologists who claim either that no damage has been done or, worse yet, if it has, what difference does it make?

In considering insecticide residues, a few principles should be understood. First of all, present-day insecticides should not be considered as non-volatile materials. When applied to crops, they dissipate or volatilize with time obeying first-order reaction kinetics (Gunther and Blinn, 1955). Volatility, as indicated by vapor pressure, is only one of many factors which influence the persistence or loss of insecticide residues. The rate of volatilization is influenced greatly by temperature. Erosion from plant surfaces by wind, rain, or mechanical means is of importance. Growth of the plant, formulation, and decomposition are other important contributing factors.

Simply because an insecticide may be toxic to man and other warm-blooded animals does not preclude its safe use, since toxicity does not necessarily constitute hazard. The Food Protection Committee of the National Research Council repeatedly has pointed out: "Toxicity is the capacity of a substance to produce injury; hazard is the probability that injury will result from the use of the substance in the quantity and in the manner proposed."

It is also imperative that the difference between acute and chronic toxicity be understood. While there are various interpretations, acute toxicity generally refers to the toxic effects arising from a single exposure, regardless of the mode of intake. Usually this will be by ingestion, but it can be by inhalation or absorption through the skin. Chronic toxicity, on the other hand, refers to toxic effects produced by multiple exposures. It is dependent upon the accumulation of sub-lethal, or at least sub-symptomatic dosages. Generally, an animal is able to tolerate considerably more toxicant if it is taken in this manner.

Toxicity values for insecticides cover a wide range, just as do their rates of loss or persistence. A comparison of two insecticides in regard to their acute and chronic toxicities to a particular animal can quite often be confusing to the uninitiated. For example, on an acute basis, parathion is roughly 70 times as toxic as DDT, but since it, unlike DDT, has very little propensity for storage in the body, it is only about four times as toxic as DDT on a chronic basis. On the other hand, gamma isomer of BHC, on an acute basis is approximately twice as toxic as DDT, while chronically it is only about one-quarter as toxic.

Considering the insecticides in common usage today, the botanicals (nicotine, rotenone, pyrethrins, and allethrin) can be considered safe because, as a rule, they are relatively unstable, non-persistent, non-toxic, and are used at low rates of application.

The older organic phosphates, TEPP and parathion, possess alarming acute toxicities. TEPP, however, hydrolyzes quite rapidly into a non-toxic substance while parathion is short-lived and is used at low concentrations. Some of the newer organic phosphates, such as malathion and chlorthion, possess insecticidal properties at reasonable dosages almost as good as those of parathion, are fairly short-lived, and yet are extremely safe to warm-blooded animals. This is a step in the right direction on the part of the toxicologists and insecticide manufacturers.

The chlorinated hydrocarbons run the gamut from some of the most toxic materials to warm-bloods in use today to some of the least. They also show a wide range in their dosage rates, persistency, and propensity for storage in the animal body. Consequently, one has considerable latitude in selecting a material to do a particular job. Fortunately, their properties are varied enough so that some of the most toxic are actually the least persistent and are effective at low dosages. The least persistent materials include aldrin, heptachlor, and gamma-BHC. Dieldrin, chlordane, and endrin may be considered moderately persistent while toxaphene, DDT, DDD, and methoxychlor fall into the highly persistent group. These materials are of concern from a chronic standpoint because they are stored to some extent in animal fat, the extent of storage varying with the insecticide. In the animal body, aldrin converts to dieldrin, is stored as such and quite naturally appears in the milk of lactating animals as dieldrin (Bann, 1956). Of the common chlorinated hydrocarbons, more storage per unit of intake in the diet occurs from feeding aldrin than from feeding any other material. In fact, more dieldrin is stored from feeding aldrin than if dieldrin were fed itself. Per unit of intake, DDT appears to accumulate at about one-sixth the rate of aldrin, while methoxychlor stores at only one-two thousandth the rate of aldrin (Gannon *et al.*, 1959). The insecticide heptachlor is stored in animal fat as heptachlor epoxide (Davidow and Radomski, 1953) at rates of about one-tenth to one-twentieth that of aldrin. Endrin appears to store at approximately the same rate (Terriere *et al.*, 1958).

Not only do aldrin and heptachlor metabolize to their epoxide forms in the animal body, but also this epoxidation has been found to take place on plant surfaces (Gannon and Decker, 1958 a and b) and in soil (Gannon and Bigger 1958). This conversion is of importance first of all because the metabolites are toxic to both insects and warm-blooded animals. Dieldrin, in general, is slightly more toxic than aldrin to insects and is slightly less toxic to warm-bloods. Heptachlor epoxide appears to be more toxic than heptachlor to both groups. Tests on mice by intravenous injection (Radomski and Davidow, 1953) and on chickens, sparrows, and Coturnix quail by contaminating the diet indicate the epoxide to be about twice as toxic as heptachlor (Gannon *et al.*, 1959).

Not only are the epoxides of aldrin and heptachlor toxic, but they are also more residual than the parent materials. Under normal conditions of spray applications to crops, one can expect the epoxides produced to persist about twice as long as the aldrin or heptachlor which was applied. From a spray of 1 pound per acre on alfalfa, one can expect an initial concentration of roughly 30 p.p.m. heptachlor or aldrin on the crop. The decline is so rapid that within 4 hours the level will have dropped to 4 to 6 p.p.m. under normal summer conditions. During the process the epoxides are formed and reach a peak between 2 and 3 p.p.m. whereupon they start to decline according to their own characteristics.

These residue values are not particularly alarming, and as such should constitute very little hazard to wildlife and no hazard whatever to larger domestic animals, even those feeding directly on the treated forage. Considering other possibilities, however, one realizes that, as yet, too many questions are unanswered. Formulation and temperature greatly influence the persistence of any insecticide, as mentioned earlier. When granules are used, the rate of loss is greatly decreased as compared to an emulsion spray. Under conditions of cool or cold weather, most insecticides will persist much longer than they will in hot, but to what extent temperature influences conversion of aldrin and heptachlor to epoxides has not been fully studied. On plants, decreased temperature slows the rate of conversion but increases the magnitude. Granules apparently convert less rapidly than sprays. No doubt some of these factors have contributed to deaths of wildlife, particularly when they are combined with overdosage and mass application. Pastures have been sprayed at overdosages of several of these materials and cows turned on to feed immediately after application with no ill effects. Neither would one expect any since in another test cows had been fed for several months on rations contaminated with insecticides at concentrations several times that which they would ever encounter under conditions of field application, again with no ill effects. (Gannon *et al.,* 1959).

From the excellent work of Rudd and Gennelly (1956), Dewitt (1955, 1956), and many others, as well as from our own work, it is obvious that levels such as these or even levels considerably less cannot be fed to certain smaller wildlife for very long without detrimental effects. On the other hand, these levels are very seldom present, at least for long, under conditions of most actual applications.

Users of insecticides where desirable wildlife are concerned have many things to consider. They are duty bound to try to select a material which will do the job on the insect but which will be as harmless as possible to the rest of the beneficial fauna.

The insecticide manufacturers together with state and federal agencies spend millions of dollars each year to insure that insecticides, when used as directed, will not be hazardous to man, domestic animals, and wildlife. The problem now is not one of determining whether unfortunate incidents have or have not occurred. Quite definitely they have. The job now is to concentrate on the reasons for their occurrence and to take steps to insure against their happening again.

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DISCUSSION

MR. JOHN BAKER [National Audubon Society]: Dr. Gannon quite correctly pointed out that aldrin and heptachlor are potent insecticides, five, ten, or twenty times as poisonous under laboratory conditions than DDT, and then he said—that we should not assume that they are more hazardous because these materials are used in smaller dosages and are less persistent.

Now, the answer to this I honestly do not know and I am asking for information. If, say, heptachlor is ten times as toxic as DDT, then, assuming that a pound per acre of DDT is a safe dose, then one tenth pound of heptachlor would be. Do you know of any cases where it has been used at this dosage?

DR. GANNON: We have come pretty close to it. A lot of treatments are put on at an eighth of a pound, which is two ounces, and when you speak of "ten times as toxic," to most things aldrin and heptachlor are not ten times as toxic. Normally the mammalian toxicity of DDT is considered to be around 250 milligrams per kilo; aldrin and heptachlor around 60 to 90. So this is not ten times, so you can use them at a quarter to a half a pound and get away with it dosagewise.

MR. BAKER: Would you consider two pounds to the acre of dieldrin or heptachlor a safe dose to be used on a large area?

DR. GANNON: It depends on the circumstances. I am speaking in generalities, of what is generally done, not what is done in some isolated instance. Now, we can speak all we want to about excess dosages, but 95 per cent of all these so-called wonder killers are applied at dosages between four and eight ounces per acre.

DR. COTTAM: I think the comments on ethics are very appropriate. If I understood the chemistry of what Dr. Gannon, has so ably presented, do you realize that there were 700,000 acres of fire ant control within this last year that were treated at the rate of two pounds—not two ounces of dieldrin or heptachlor per acre; and it seems to me that that is just a little excessive

MR. MAX GOEBEL [Delaware]: I am an employee of du Pont, and it happened that the name of one of our products was mentioned by the speaker, which happens to be for all practical purposes the only insecticide we sell.

The lady spoke about the contamination of milk by DDT. I would only like to say that where methoxychlor is used on dairy cattle we sell it under a zero tolerance from the Food and Drug Administration. This is just for the record.

MR. HOWARD GLAZENER [Texas]: Dr. Gannon, have you done work to determine the effect of these soil residues on some of the beneficial forms, such as earthworms and/or soil micro-organisms?

DR. GANNON: We haven't done any work along those lines. I think your question should have been directed to Dr. Haller from the soil insecticide standpoint.

DR. HALLER: Soon after we began work with DDT almost fourteen years ago that was one of the first things we began to study, to see whether or not DDT had any deleterious effect on soil micro-organisms. We did not find any deleterious effects of DDT, using it in rather sizable quantities—up to 100 pounds per acre—at that time. DDT has no bactericidal action, nor has it any effect upon soil microorganisms in the experiments that we carried out in the greenhouse.

It is taken up by earthworms, but I don't think earthworms are killed by it. Now that you have brought it up, there have been sizable quantities reported to have been present in earthworms, but there are no reports that the earthworms have been killed by this DDT.

MRS. WALLER: What about the birds that eat them?

DR. HALLER: Well, that hasn't been proved. That is speculation.

MR. CLAUDE D. KELLEY [Alabama]: I was on an area in Louisiana and the earthworms killed ranged between 70 and 80 per cent after an initial application of heptachlor.

DR. HALLER: He brought up the point of DDT; and I haven't seen anything on heptachlor. I am not trying to withhold anything. I just don't know and

I understand from Dr. Decker that others will bring it up.

DISCUSSION LEADER ARANT: Dr. Haller and Dr. Gannon both referred to the relatively short residual of heptachlor and it does have a rather short residual on forage. However the work of Blake, Eden and Hayes has shown rather conclusively that in some of the fire ant control work, for example, heptachlor applied at two pounds per acre is still controlling fire ants in its fourth year. I don't know what the mechanics are. I wonder if either Dr. Haller or Dr. Gannon would want to comment.

Maybe you don't want to comment at all, but that is an observation that has been made in that connection. Would you want to comment?

DR. GANNON: Well, this is back to soil again, but when we have applied any of these materials to soil and worked it into the soil, essentially we are putting it back in the can and putting the lid back on. It is not quite that bad, but they persist for a long time under those conditions where they would not on the surface of the soil or on a plant.

DR. HALLER: We are perfectly willing to discuss this subject at any time and present our views. As Dr. Decker says, we are not here to try to make any converts but we would like to present our side of this story.

The fire ant program is one of eradication and the fire ant program is one that was demanded to be carried out by Congress. It was one that was not initiated by the Department of Agriculture on its own and we have been working consistently now ever since the initiation of that eradication program to try to find better ways of using better insecticides, and I believe that we are reaching the stage where we are about ready to produce the amount of heptachlor as an example to be used for eradication; so it isn't something that we have taken lightly. We do not simply go ahead and broadcast these insecticides without regard to the hazards that may be involved; so the answer is that it is quite likely that we will recommend less of the heptachlor within a relatively short time; and bear in mind it is an eradication program and not one where it will be used year after year.

MR. KELLEY: I would like to point out something in regard to eradication. I have in my possesion a memorandum from the Plant Pest Control Division which states that there are approximately 27 million acres of land in the South with fire ants but it is their thinking that they will not treat over one million acres in any one year nor over 200,000 acres in any one state. My state, Alabama, has over 11,500,000 of infested land. That means that it would take between 55 and 57 years to treat the infested land in my state with the residual effects for three to five years of the poisons.

Gentlemen, I am saying that they are not dealing in an eradication program.

CHAIRMAN DECKER: We shall have a paper dealing with parts of the fire ant program. There will be no further discussion of fire ants at this moment.

Let us remember that is one problem—most of these speakers have been talking in terms of insecticides and wildlife and biological relationships. If there is one program, if there is one operation, if there is one misuse, let us be specific about that.

Now, pesticides may kill insects within the soil over a period of time and yet we might not consider it a hazard. If the material was carried back to the nest or is a constant part of the diet or environment of animals living within it, as many insects do—it is a hazard, but even in these cases insects which run tremendous amounts of soil through them are readily, quite easily, killed. But you can put termites into the same soil and they will eat the wood and the fact that they walk through the treated soil does not mean that they are killed. The chemical is quite tightly bound to the soil. It is not readily pulled loose or readily available to all the organisms that are there.

There was one question about soil organisms. We don't know all about that. When they first came out our soil specialists at the University of Illinois ran DDT and some of the related materials and they were asked: Will these chemicals kill the valuable bacteria and organisms in the soil? And they said, "Yes. If you put enough on, but there are a lot of cheaper ways to do it." In other words, it had to be in applications of 100 and 200 pounds per acre.

The University of Wisconsin has an extensive project which tends to bear out the same thing. Sometimes you get a surprise. There is one of the important soil bacteria which metabolizes and derives energy from the decomposition of aldrin, so it becomes a food and not a toxic substance.

We have tremendous quantities of data on the residue losses and residue dissipation under all kinds of field conditions. We also have tremendous amounts of data on animal toxicity, particularly with rats, of course, but also with many domestic animals. This is acute toxicity that you are looking at in the tables. How much can you take in one dose and kill half of the organism? And that is what you base this on. Those dosages were generally low, but comparing aldrin or heptachlor with DDT, and applying them at the same rate, there will be twenty times as much DDT there at the end of a week as there will be aldrin at the end of 24 to 48 hours; so there are several factors working and it is improper to take any one of those criteria and draw too many conclusions. You have to take the long-time exposure and determine how available that chemical will be over that long period of time before you can arrive at a true toxicological evaluation.

POLLUTIONAL EFFECTS OF ORGANIC INSECTICIDES

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While "pollution" and "pollutant" are common terms they are often used in a rather indefinite manner, and there is no universal agreement as to their definition. Before describing the pollutional effects of the new organic insecticides it is advisable to define these terms. As used herein, pollution is a change in the physical, chemical, or biological quality of a water due to certain of man's activities or the addition of substances or mixture of substances which interfere with, lessen, or destroy a use of that water. A pollutant is any material or complex of sustances which renders water less effective or unfit for a desired use. The generally accepted uses of our water resources are for domestic and industrial supplies, for irrigation, and other agricultural uses, for the propagation of sport and food fishes, and for recreation, navigation, and waste disposal. Another very real but difficult-to-evaluate asset of our lakes and streams is their aesthetic value. It is hoped that this important intrinsic value of clean water will be more widely recognized and appreciated in the future. The aesthetic and recreational value of pure natural waters will increase directly with population and inversely to their availability and extent.

Although there is general agreement as to the beneficial uses of water, there is considerable disagreement as to the relative importance of these uses and the need for their preservation. The training and experience of a person usually determine his attitude and sense of values. The modern need for specialization is resulting in many having a narrow view and a lack of appreciation of the different uses of our resources and the need for their preservation and wise use. This creates serious problems in the prevention or abatement of certain types of pollution.

Generally, pollutants are thought of as being added to a stream at a point source. However, insecticides have come to resemble eroded materials in that their source may be an entire watershed. Pollutants of this type are not amenable to accepted means of treatment. In the case of insecticides, the only means of control is to limit their application or to use materials which do not interfere with the important uses of the water into which they may find their way. With present application methods organic pesticides may enter waters in one or more of three ways. They may be applied directly to the water surface, they may drift onto water during the treatment of adjacent areas, or they may be washed in from treated areas of the watershed.

TRENDS AND GROWTH IN PESTICIDE USE

The use of chemicals for the control of mosquito larvae created one of the first toxic pesticide problems for aquatic biologists. Oil was generally used during the early years but was replaced in many areas by Paris green after airplane dusting methods were developed. The widespread and intensive use of Paris green and oil by the TVA during the 1930's was criticized by conservationists and fishery and wildlife workers. A cooperative study in the late 1930's of the effects on wildlife of the routine use of these chemicals demonstrated that oil was definitely inimical to many of the fish food organisms, especially those in floating vegetation, but the effects of Paris green were not so clear. It is now known that emulsified oil is toxic to fishes at a fraction of a part per million. During this period, with the exception of a few materials such as pyrethrum and derris, all insecticides were inorganic materials. Also previous to 1943, the greatest threat to aquatic life from pesticides was their use for the control of insect vectors of disease, chiefly the malaria mosquito.

The advent of DDT during World War II was the beginning of a drastic change in the character and scope of the problem of pollution by pesticides. This contact insecticide, with its great toxicity to a wide variety of organisms and its residual properties, completely changed many of the approaches to insect control and its effects on other organisms. The immediate success of DDT, first used in control operations in 1944 and 1945, caused many to abandon established control practices and to rely solely upon chemical control of vectors and pests. Thus, there was a rapid increase in the variety of its uses and in the areas treated. New formulations and methods of application were rapidly developed. Dusts, solutions, emulsions, and aerosols were broadcast by ground and air equipment, not only for the control of insect vectors of disease but also for the control of forest and agricultural pests. Since DDT was used for control of both larvae and adults, some species, especially the flies, developed a resistance to it. This resistance, plus the great potential market for organic pesticides demonstrated by the sales of DDT, led to the development of new and more toxic materials.

In 1943 there was only one synthetic organic insecticide on the market. In 1955, there were over a hundred different materials being used commedcially (Metcalf, 1955), and these were available in thousands of different formulations. From 1940 to 1950 there was a threefold increase in the use of insecticides, and from 1950 to 1955, the amount used doubled again. According to a report of the Chemical Specialties Manufacturing Association, sales of liquid insecticide totalled 10.4 million gallons in 1954, an increase of 21 per cent over 1953. Since 1955, the total amount used has about doubled again. It has been estimated that three billion pounds of formulated insecticides were applied in 1956, and that a total of 65 million acres of crop land were treated that year. It has been reported that cotton crops are treated annually with three to seven pounds per acre of technical grade insecticide. In north Alabama during 1950, a wet year, 30 to 300 pounds of formulated insecticides were applied per acre.

With this amount of highly toxic materials being broadcast over the land, it is inevitable that some of it will reach our water courses in concentrations which are toxic to aquatic life. Numerous examples of the presence of these materials in our waters have been recorded. Fish kills due to insecticides have occurred in several streams (Young and Nicholson, 1951; Burden, 1956; Rudd and Genelly, 1956; and Ide, 1957). Analysis of samples taken in connection with several Public Health Service investigations and the National Water Quality Basic Data Program has shown the presence of insecticides in soil, the runoff from treated areas, and in our major rivers. Soil samples from Alabama cotton fields, treated with Toxaphene during the summer, still contained amounts of material which were lethal to fish the following November (Doudoroff, Katz, and Tarzwell, 1953).

Runoff from areas treated with Dieldrin at about five pounds per acre for white fringed beetle control was toxic to fish in dilutions of one in three (Tarzwell and Henderson, 1957). A sample of a domestic water sent in by the Fish and Wildlife Service from an orchard area of Pennsylvania was found to be lethal to all test fish in four hours. During the cotton spraying season of 1950, both the raw and finished water of a plant taking its supply from a stream draining agricultural areas were lethal to fishes. Further, in the course of examining various surface and drinking waters by means of concentrating the organics by the carbon filter method and analyzing concentrates, DDT has been identified in several instances. At certain times it has been found in Lake St. Clair, the Detroit River (Middleton and Rosen, 1956), the Mississippi River at Quincy, Illinois, and at New Orleans, in the Missouri River at Kansas City, and in the Columbia River at Bonneville Dam. While the method of handling and recovery does not permit an exact quantitative estimate of the DDT present, it is believed that 1 to 20 parts per billion may have been present in the water at the time the samples were collected. The general indication is that 5 to 10 parts per billion would be a common level in the water examined. While these small concentrations have no significance from the standpoint of toxicity to humans as drinking water contaminants, they are approaching levels which may be toxic to fish under conditions of continuous exposure. If other more toxic insecticides occurred at these levels, a very serious and widespread pollution problem would result.

The possible toxicity of the new organic insecticides to aquatic life was recognized at an early date. A great deal of work has been carried out by a number of investigators on the effects of these materials on fish and certain other members of the aquatic biota. Since DDT was the first one to be widely used, its effects have been most intensively studied and many reports on its toxicity are available (Ingram and Tarzwell, 1954). While most studies were concerned with the effects of single applications, those carried on by the public Health Service at Savannah, Georgia, in 1945 and 1946, were designed to determine the effects of routine applications of DDT as used in actual malaria control operations. The purpose of these studies was to determine formulations, methods of application, and dosages of DDT effective for malaria control and least harmful to other elements of the aquatic biota. On the basis of these studies (Tarzwell, 1947, 1948, and 1950), it was recommended that for malaria control hand applications should not exceed 0.05 pound of DDT per acre, while applications by airplane should not exceed 0.1 pound per acre. The latter dosage was larger because only a portion of the material reached the water surface. A study of the effects of routine weekly airplane applications of DDT at 0.1 pound per acre over a three year period did not demonstrate any measurable harm to fish populations in the treated areas. It was found that DDT is apparently adsorbed and inactivated by soil particles and organic materials. Subsequent studies with Toxaphene and Dieldrin indicated that either these materials are not inactivated by the soil, or the dosage was such that the capacity of the soil to adsorb and inactivate them was exceeded.

It is unfortunate that extensive field studies, such as were carried out with DDT, have not been made with the other organic insecticides which have appeared subsequently.

TOXICITY OF THE NEW INSECTICIDES

For the past several years laboratory studies have been carried out at the Robert A. Taft Sanitary Engineering Center to determine the toxicity of new organic insecticides to fishes. Some of these materials are more toxic to fishes than DDT, while others are less toxic. Bioassay procedures and the methods of reporting results are those described by Doudoroff, et al. (1951) and Henderson and Tarzwell (1957). Results are reported as median tolerance limits, TL_m. The median tolerance limit for a particular material is the concentration of that material in the dilution water being used which causes a 50 per cent mortality of the test fish in a specified time. Tests are run 48 to 96 hours or longer. Thus, the 48 hour TL_m for DDT is that concentration of the material expressed in parts per million which will kill half the test fish in 48 hours. The TL_m values are obtained by straight line interpolation from points representing per cent survival of fish and log concentrations of the material in question which bracket the 50 per cent survival point as explained by Henderson and Tarzwell (1957).

Bioassay investigations of the new insecticides indicate that in general the organic phosphorus compounds are not as toxic to fishes as are the chlorinated hydrocarbons. The toxicity of most of these materials is not significantly influenced by water quality. Therefore, it is to be expected that the toxicity of these materials will not differ significantly in different streams. While there are some differences due to hardness they are neither uniformly in one direction nor are they great in extent. The toxicities of these materials as indicated by the 96-hour TL_m of fathead minnows, *Pimephales promelas,* and bluegills, *Lepomis macrochirus,* are shown in Table 1. A comparison of the values given in the table clearly demonstrates the much greater toxicity of the chlorinated hydrocarbons. With the exception of BHC, all are toxic to fishes at concentrations of less than 0.1 part per million, and three are toxic to bluegills at concentrations considerably below 0.01 part per million. Endrin is the most toxic material to fishes which has been tested to date, being toxic to bluegills at 0.6 of a part per billion. Its TL_m for trout is about a third of a part per billion. Of the organic phosphorus compounds which have been tested, Guthion is by far the most toxic to fishes. It ranks fourth in toxicity among the materials tested, coming after Endrin, Toxaphene, and Dieldrin.

In general, bluegills are as sensitive or more sensitive to these materials than the other fish tested. When their sensitivity to the chlorinated hydrocarbons is compared to that of the fathead minnow, it

TABLE 1.[1]—THE TOXICITY OF THE NEW ORGANIC INSECTICIDES TO FATHEAD MINNOWS AND BLUEGILLS AS INDICATED BY THEIR 96 HOUR MEDIAN TOLERANCE LIMITS EXPRESSED IN PARTS PER MILLION.[2]

Organic Phosphates	Fathead Minnows	Bluegills	Chlorinated Hydrocarbons	Fathead Minnows	Bluegills
Dipterex	180		Sevin[3]	12.0	5.3
OMPA	121		BHC	2.3	0.790
Co-ral	>18	0.18	Heptachlor	0.094	0.019
Malathion	17	0.095	Methoxychlor	0.064	0.062
Methyl parathion	8.3		Lindane	0.062	0.077
Di-syston	3.7	0.064	Chlordane	0.052	0.022
Systox	3.6		Aldrin	0.033	0.013
Chlorothion	3.2		DDT	0.032	0.016
Parathion	1.4	0.700	Dieldrin	0.016	0.0079
TEPP	1.7	0.840	Toxaphene	0.0075	0.0035
Para-oxon	0.33		Endrin	0.0010	0.0006
EPN	0.20				
Guthion	0.093	0.0052			

[1]Data from Henderson, Pickering, and Tarzwell, 1959.
[2]All tests made in soft water at 25° C.
[3]This material is a carbamate and not a chlorinated hydrocarbon.

ranges from about equal to almost five times as great. With the organic phosphorus compounds, as indicated in Table 1, the differences are much greater. Malathion is the outstanding example; it is almost 180 times more toxic to bluegills than to fathead minnows. These results clearly indicate the impossibility of judging the toxicity of these materials to all fishes on the basis of tests with one species. Further, these tests show that one species is not always sensitive while another is resistant. Resistance and sensitivity among the species varies with the material being tested.

With most of the organic phosphorus compounds there were only minor increases in fish mortality between the 24 and 96-hour periods. This is to be expected with those materials which rapidly hydrolyze to less toxic materials. It is especially the case with TEPP (50 per cent of which hydrolyzes in 6.8 hours at 25° C.) as it caused no fish mortality after 24 hours. With OMPA, which hydrolyzes very slowly, and with Dipterex, which is converted to a highly toxic material, there was a considerable increase in fish mortality between the 24 and 96-hour periods. An increase in fish mortality between 24 and 96 hour exposure periods was noted for practically all the chlorinated hydrocarbons. With continuously renewed solutions of DDT and Endrin, the 20 day TL_m was approximately half (toxicity twice) that obtained in

96 hours. It would appear that these materials are an accumulative poison in fish and as such may be very serious pollutants.

When the 96-hour TL_m values for bluegills in Table 1 are used to compute the rates of application necessary to achieve the concentration of each of these materials which is lethal to half the fish it is found that very small amounts may be detrimental in natural waters. On a per acre basis the calculated amounts of each of the more toxic insecticides which may kill half the fish in water three feet deep (three acre feet) are as follows: Endrin, 0.005 pound; Toxaphene, 0.03 pound; Guthion, 0.04 pound; Dieldrin, 0.07 pound; DDT, 0.13 pound; Heptachlor, 0.16 pound; Di-syston, 0.52 pound; Lindane, 0.62 pound; and Malathion, 0.78 pound. It can be seen that aerial spraying of water areas with any of these compounds at the rate of 1 to 2 pounds per acre, normally used on land areas, could be disastrous to fish life. Runoff from surrounding treated areas also could be detrimental, and it is quite apparent that the widespread use of these materials can result in water pollution.

For some of the materials listed in Table 1, the normal rate of application is well below the calculated amount required to kill half the fish in water three feet deep. The corresponding amounts of these materials are as follows: Parathion, 5.7 pounds per acre; BHC, 6.4 pounds; and Sevin, 43.3 pounds. If these materials and certain of the organic phosphorus compounds which hydrolyze rapidly could be used for the control of agricultural and forest pests, the threat to the aquatic biota would be greatly reduced.

In considering the effects of any of these insecticides on aquatic life it must be remembered that the values listed in Table 1 and the pounds per acre listed above are the amounts which will, under laboratory conditions, kill half the fish in 96 hours. Amounts safe for aquatic life under conditions of continuous exposure are considerably less and may be one-fifth to one-tenth of these values. Much more research is needed before safe concentrations or application rates can be established to insure the protection of the aquatic biota. Full-scale field tests are needed in order to evaluate all the variables which may affect the toxicity of these materials to aquatic life in our lakes and streams. Preferably, these should be completed on all new materials before they are released for widespread use.

SUMMARY AND CONCLUSIONS

Many of the new synthetic organic insecticides are extremely toxic to fishes. Endrin, Dieldrin, Toxaphene, Guthion, and DDT are acutely toxic to fishes at very low concentrations. Long-term studies with some of these have demonstrated that as the period of exposure is increased, concentrations which are toxic become correspondingly smaller. Amounts of these materials usually applied for the control of forest and agricultural pests, if they are also directly applied to the water surface, are sufficient to decimate aquatic populations. Many of these materials have a long residual toxicity in the soil, and runoff from treated areas has been toxic to fishes in several instances. Extensive kills have already resulted in several areas. The widespread use of these materials, is, therefore, creating an immediate pollution problem.

The effect on the biota of continuous exposure to low levels of these materials is yet to be determined. Indications are that it can become a serious problem. Since the toxicity of some of these materials varies widely with the species, acute toxicities must be determined for all important species or related groups. Furthermore, concentrations which are safe under conditions of continuous exposure must be determined. Since the toxicity of these materials is not markedly affected by water quality this can perhaps be effectively accomplished by the development of application factors which can be used with TL_m values to indicate safe concentrations for continuous exposure.

Studies should also be made with each of the new insecticides to determine the toxicity of runoff and seepage water from various soil types, slopes, and vegetative covers for different dosages, formulations, and modes of treatment.

There are certain measures which can be taken to lessen or abate stream pollution due to the widespread use of the new synthetic organic insecticides. These are as follows:

1. Use spot control in preference to broadcasting the toxicant over wide areas.
2. When a certain pesticide is to be used for the control of a particular species, determine the smallest dosage which is effective for the control of that species and do not exceed it in control operations.
3. Before beginning extensive control operations, determine the formulation, method of application, and the material which is least toxic for other members of the biota.
4. If the above has been done and it is found that in spite of this all the efficient pesticides will seriously affect other organisms in the biota, give consideration to the use of a material which while less effective for the control of the pest species is not so toxic or is relatively nontoxic to other important organisms.
5. Use narrow spectrum or specific pesticides.

In the past the demand has been for more toxic and broad spectrum insecticides. This is due to the development of resistance in some species and to the desire to take care of all pest problems with one treatment. The use of such materials usually results in harm to a considerable portion of the biota. It is believed that this trend must be reversed and that there must be a concentration on the development of narrow spectrum or specific insecticides if serious future pollution problems are to be avoided. The development of a specific material for a given species would allow its widespread use without harm to other organisms. It is believed that such narrow spectrum or specific pesticides must be developed if we are to preserve our water resources in many areas.

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DISCUSSION

DR. CLARENCE COTTAM: Dr. Tarzwell, you mentioned the fifty per cent survival. I wondered if any study has been made of the survival as regards ability to survive for a length of time, ability to reproduce, or longevity in comparison with the normal. It seems to me that you are studying those that are killed immediately.

Have you made any study on whether the others might have survived any normal length of time?

DR. TARZWELL: We have not made studies of the effects of these materials on fishes under conditions of continuous exposure. Our studies do not give information of any effects that these materials may have on reproduction or longevity. It is true we have studied only the immediate effects. Further, we have not had the facilities or the manpower to carry out physiological studies in order to determine effects which while not lethal are definitely detrimental. We have, however, carried out some thirty day studies to determine the toxicity of some of these materials in continuously renewed solutions of the pesticides. We have found that in some of them, the lengthening of the exposure drastically reduces the amount which is toxic. I would like to point out that our primary task is the determination of the toxicity of various materials to fishes as they relate to water pollution. There are a host of such materials being released to our waters, chiefly as industrial wastes. This is a very large problem and we can devote only a portion of our time to the pesticides. We have, therefore, largely confined our work to short time studies and have expressed the results as the 96-hour TL_m value. This we believe to be the first step in the rapid evaluation of these materials. We are interested, however, not in the concentration which kills half the fish in a short time but in the amount of material which is safe under conditions of continuous exposure. That is why we are carrying out the thirty day studies for the purpose of developing what we have termed application factors which might be applied to the TL_m value obtained in our short time tests to indicate concentrations which are safe under conditions of continuous exposure.

MR. MCLAUGHLIN [New Jersey Audubon Society]: Dr. Tarzwell, did your research include the contamination or the percentage of toxicity remaining in the fish? In other words, would it affect other animals in digesting the dead fish killed by DDT?

DR. TARZWELL: We have not investigated the accumulation of DDT in fishes. I do know that DDT has been reported to be present in the bodies of fishes which have been killed by it. I doubt very much if it would be found in quantities sufficient to be toxic to other animals which might eat the fish. I would like to point out at this time that DDT reacts somewhat differently in natural waters than toxaphene or dieldrin. In my studies at Savannah, Georgia, in the mid forties, I found that DDT was tied up and inactivated by soil particles and organic materials. It appears that clay soil or turbidity in the water is quite effective in adsorbing DDT and nullifying its toxicity. I treated one pond at the rate of .1 of a pound per acre 18 times. After completion of the treatments in the fall the pond dried up and I took a sample of the bottom materials from a measured area. When this soil material was mixed with water it did not kill mosquitoes. However, when the soil was extracted with xylene a few drops of the extract would kill the mosquitoes, indicating that it had taken up the DDT from the soil. We analyzed this soil material and found that it contained DDT in an amount equivalent to 0.82 of a pound per acre. This is almost half of the original amount applied and is several times the amount required to kill fishes. As another example fish were killed in a sand bottom pond after two applications of 0.05 pound per acre, whereas in another pond containing more organic material and having clay turbidity no fish kill resulted from 14 treatments at 0.1 pound per acre.

Evidence we have at hand indicates that toxaphene and dieldrin are not tied up and inactivated in this way or else the amount applied exceeded that which would be inactivated by the soil. Soil samples taken in late summer from a cotton field which had received treatments with toxaphene were toxic to fish the next November. Studies carried on in Georgia show that runoff from an area treated for white fringed beetle control at the rate of about 5 pounds of dieldrin per acre were toxic to fish in a dilution of 1 in 3.

DISCUSSION LEADER ARANT. This problem of insecticides and their very high toxicity is a very complicated one. When the fire ant control and eradication program came along we envisioned a great deal of trouble in killing of fish in the numerous ponds in the state. Actually, 2 pounds of heptachlor and 2 pounds of dieldrin has been applied right down to the edges of many fishponds without any kill whatever of the fish in these ponds. It has been somewhat puzzling, because the materials are so highly toxic that you would expect some kill. There has been kill where the water itself has been treated accidentally, or for some other reason, but these points emphasize the fact that there are many things that we yet don't know about these chemicals and how they act.

MR. ZICARDI: I would like to ask Dr. Tarzwell whether or not they have done any studies on the problem of potentiation. That is, what studies have been done concerning combinations of chlorinated hydrocarbons or a combination of organic phosphates or combinations of the two?

DR. TARZWELL: We have not studied combinations. I cannot answer that.

WILDLIFE AND THE FIRE ANT PROGRAM

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It is impossible because of limited time to present to you an adequate background for such a subject as the fire ant and the effect its control program has on wildlife. Therefore this introduction is of necessity rather sketchy. An excellent review of the problem was made by George (1958). All information contained in this report refers to the imported fire ant *(Solenopsis saevissima richteri)*.

The ant is believed to have entered this country near Mobile, Alabama, about 40 years ago and has spread over 20 to 30 million acres in the southeastern states. It is considered a nuisance because of its irritating sting and mound-building activities. The colony builds large mounds and at the population peak there may be 125-150 mounds per acre. The stable population is often less than half the peak population. Mounds are troublesome to landowners during hay cutting operations.

An eradication program was begun in the fall of 1957 by the Plant Pest Control Division of the U. S. Department of Agriculture. This eradication program is a cooperative one with costs being shared by the Federal Government, the States, and in most instances by local landowners.

Eradication is by application, aerially or from the ground, of two pounds per acre of active heptachlor or dieldrin in granular form.

These two chemicals are approximately 10 to 20 times more poisonous to wildlife than DDT and retain their toxicity to ants for a period of three years. The usual treatment is from the air. Plant Pest Control personnel supervise the program but aerial application is executed by private contractors. Prior to treatment instructions regarding the dangers of the poisons are given to all residents of an area.

Congress appropriated 2.4 million for operation of the program in 1958. This money is used on a matching basis with state and local funds. Present cost of treatment is 3 to 4 dollars per acre. Assuming treatment costs remain the same and that 25 million acres will be treated, the eventual total cost will be well over 100 million dollars. A staggering sized control program for which very little research is available!

Farmers generally favor the program, but there is a growing hesitancy in Louisiana to sign up for treatment so freely because of the increase in the sugarcane borer. (Long, *et al.*, 1958). Others are hesitant because of the suspected increase in the rice stink bug and reports of livestock losses.

Since the initiation of the present fire ant control program, several statements have appeared in print implying that the ant is destructive to wildlife. There is little or no evidence to support the statements, and wildlife biologists studying the influence of the ant on wildlife are more concerned about the control program than the ant. The spreading of false information—such as, the fire ant is responsible for the low quail population in St. Tammany Parish, Louisiana and that fire ants killed out the muskrats in the southeastern section of the parish—is common.

The fire ant has been present in the Mobile Bay area of Alabama for 40 years, yet quail and rabbit hunters of the region report good hunting success. Arant, *et al.* (1958) state that the percentage of young quail to old in the hunter's bag has been as high or higher in areas with heavy populations of the imported fire ant than in areas where it does not occur. I have heard of no studies which support the contention that the ant is detrimental to a game species.

Casual observations in treated areas and landowner reports have misled some administering personnel to believe that little wildlife damage is occurring. Farmer reports are very conflicting. I have talked to farmers who reported to U.S.D.A. personnel that there were no wildlife losses but listed for me both species and numbers of birds and mammals found dead on their land following treatment. I have had farmers tell me that they had not observed dead birds or mammals, but at the next visit they could recall several. One man may tell you all his quail and rabbits were wiped out and that he saw many dead birds, while his neighbor whose land is separated by a barbed-wire fence flatly swears that no mortality occurred on his farm.

Most carefully conducted studies have shown a high initial kill of wildlife. Rosene (1958) made whistling cock counts of bobwhite quail on six areas that had been treated with heptachlor or dieldrin and on six untreated control areas in Decatur County, Georgia. About 10,000 acres of each type were censused on treated transects. The areas were checked between May 22 and July 12, 1958. Rosene found an average of 3.74 whistling cocks per 1,000 acres on treated land and 27.43 per 1,000 acres on untreated land. With one exception birds that were heard on treated areas were close to the border. Baker (1958) reported the loss of 13 coveys of quail on treated lands near Camden, Alabama. The few coveys that survived were found on the treated land only once in seven sightings. Baker further reported the loss of 53 different kinds of vertebrates representing over 187 specimens.

Glasgow (1958) reported the death of many birds and mammals on two treated areas in Louisiana. In one community 72 domestic ducks were killed on treated land and other unverified duck losses were received. Wills (1958) reported that a cotton planter near Vidalia, Louisiana, lost over 90 domestic geese a few days after treatment. The surviving geese were recently rounded up, and additional birds died.

Lay (1958) reported the loss of 114 birds representing 19 species plus several wild mammals on treated land in Texas. Lay also stated that at the end of four weeks 13 of 20 redwing blackbird nests on untreated lands and 3 of 34 on treated lands had either hatched or were being incubated normally. Glasgow (1958) found that young fledged from only one of 49 redwing blackbird nests that contained young or eggs at the time of treatment.

With few exceptions, dead specimens that were analyzed from treated areas contained heptachlor or dieldrin. Because dead birds and mammals are generally difficult to find, the mortality reported for these studies is less than the actual kill.

Little loss of wildlife was reported by Jenkins (1958) from a study area in Georgia. Size of the treated area may have been responsible for the light kill. Previous studies have shown that species ranging off and on a treated area may survive.

DeWitt (1956) has shown that sublethal doses of chlorinated hydrocarbons reduce egg production and viability and increase mortality of chicks of quail and pheasant. Unconfirmed reports indicate that turkeys failed to produce young on some treated areas. The seriousness of chronic poisoning to wildlife in the wild is not known.

Birds and mammals are now present on most treated areas. The rate at which wildlife species repopulate them seems to be correlated with the size of the treated block, the wildlife species involved and perhaps the conditions existing at treatment. Subnormal populations were evident on most areas at least 5-7 months following treatment. Some areas were below normal 10-12 months after treatment. Quail are present on some areas. Rabbit hunters found poor to moderate hunting success eight months after treatment on one area in Louisiana. Courting rabbits were found on two other areas about nine months after treatment. Hunters reported no rabbits on another area six months after treatment.

No major woodcock wintering areas were treated in Louisiana. Therefore little is known of the control program's effect on the birds. Earthworms were not only reduced in numbers but they were also contaminated with heptachlor 8 to 11 months after treatment. They may be a hazard to ground feeding birds.

Careless applicators have created an unnecessary hazard for wildlife. Even though the administering agencies have stringent rules for distribution of the poisons, proper or improper application is determined by "the man in the plane." Treatment from the air has resulted in overdoses of poisons, treatment of "flagged out" areas and just plain dumping of chemicals. More careful selection of pilots is desirable.

The following information has no biological significance in solving the fire ant-wildlife problem but it is important. Exaggeration on the part of ant eradication personnel and wildlife biologists has occurred too frequently. Wildlife people have dabbled in public health problems and domestic livestock losses. Fire ant control personnel have been prone to have ready answers for all wildlife problems. They have ridiculed sound biological data as well as game biologists, even going so far as to ask for the removal of game personnel. Some chemical companies have contributed to the confusion by distributing misleading information. The lack of objectivity on the part of both wildlife and control personnel has created ill feelings and caused the loss of the confidence of the public. This has made working conditions unpleasant for both groups. Let's hope the more rational and objective trend that seems to be developing continues.

SUMMARY

No one connected with the program desires to kill wildlife. I know this to be especially true in Louisiana, but under the present practices there is no way of preventing it.

When large blocks are treated, there is a high initial kill of wildlife, the seriousness of which has not been determined. Sublethal doses of the poisons as well as contamination of the food supply are undoubtedly serious to wildlife. Game species are moving into many of the treated areas but the rate of repopulation has been rather slow.

Careless application of the poisons has resulted in unnecessary wildlife mortality. Because of the conflicting evidence released to the press, and because of unethical actions, Entomologists as well as game biologists are losing the faith and respect of the people.

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DISCUSSION

MR. STEINGARTEN [New York, N. Y.]: The question I have: For a long time the fire ant stayed in the immediate vicinity of Mobile, Alabama, and suddenly—about two years ago—it started spreading and is now covering the Southeast. What accounts for the sudden spread?

DR. GLASGOW: That is a question I would like to refer to another person.

Dr. Arant, would you care to comment on that?

DISCUSSION LEADER ARANT: I cannot answer the question. It may be just a matter of building up population. If you double a penny and keep doubling it often enough, after a while you get a lot of money piled up. I don't think that is the whole problem, however, and I am sure that I don't know just exactly what the answer is.

The fire ant did not suddenly break from its area. For example, it was pretty well scattered even over central Alabama as early as 1948 and '49 in small numbers. The mounds were small. In many instances people didn't see them or didn't recognize them and then they just seemed to burst out everywhere.

Another factor may be the soil type. The ants seem to spread particularly rapidly in the Black Belt soils the very fertile soils of central Alabama. Insect populations are high there. We presume they have a lot of food in these soils, and maybe that accelerated the rate of spread.

There have been some theories, of course, that we have hybridization there.

MRS. WALLER: I wonder whether the Department of Agriculture enforced its restriction that cattle should not be put on pasture land that had received the spray treatment for thirty days?

DR. GLASGOW: Again you have a question that is out of my field. Although I will reserve the privilege of answering, I would like comments from other people.

DR. LEE POPHAM [Agricultural Research Service]: My name is Lee Popham, with the Agricultural Research Service and I have had a little to do with the Federal part of the fire ant program.

It is not a matter of the U. S. Department of Agriculture enforcing anything. We advise farmers to keep their livestock off pastures that have been treated for specified lengths of time.

Now, I think you will find in a publication from Auburn a statement to the effect that it is not necessary to remove livestock from a pasture treated with 2 pounds of granulars under proper supervision.

MRS. WALLER: That is what I hoped you would say. I wanted to know what the reaction of the local Board of Health, or those to whom the Alabama farmers sell milk, is to milk being sold from herds that have been pastured on land that has been sprayed.

DISCUSSION LEADER ARANT: I think Dr. Popham misquoted a little bit. Beef animals only; not dairy animals under any circumstances.

DR. POPHAM: You know, I am becoming one of the most conservation conscious people in the United States.

I would just like to say this about the fire ant, white fringe beetles, gypsy moth or any of these programs which are undertaken where there is Federal participation to some degree, one of the first things we do is to get together with the public health people, outline the procedures that we are proposing to use, thrash it out as to what the risks are and whether the program is worth the risk.

So in dealing with a program of this kind, we hope we will see the time when we will be able to say without hesitation, "There is no health risk. There is no risk to fish and wildlife or beneficial insects." We feel that the procedures that we are using with the counsel of public health people—remove any risk to the health of the people in the area where the treatments are being applied. Unfortunately, right from the beginning, these programs we have known that under certain circumstances some wildlife would be killed. We are hoping, and doing everything we can, to stimulate interest in finding out just how significant these losses may be and what the repopulation rate is. Are there things that we are doing that we shouldn't do, or that we can do better? And we are certainly hoping to welcome any constructive thoughts along that line.

DISCUSSION LEADER ARANT: Dr. Glasgow!

DR. GLASGOW: I know that the control people have given some very good instructions on the removal of livestock, but I have had some farmers want strongly to convince me that heptachlor doesn't bother dairy cattle. One fellow in particular said, "Look at my cattle. I didn't take them out of the field all the time they were putting it down. I haven't taken them out since and I have sold my milk to the dairy every day."

MRS. WALLER: Let us have some of the milk tested. That is all I would like to have them to do.

CHAIRMAN DECKER: I want to interrupt here a moment. You may recall that in a previous discussion period the question of fire ants came up and somebody challenged eradication, and my friend Dr. Popham arose to his feet and I told him to sit down. Now I am going to give him the chance to stand up again because I think he certainly is entitled to it and I told him his time would come now. Then we will go on.

DR. POPHAM: I don't want to pursue this and I don't want to take a lot of time. There are a couple of things, though, that I would like to comment on briefly. Reference has been made, not only at this meeting but at several others, to the acreage involved. Now, when we, the responsible state agencies and our Agency in the Federal Government, are asked the magnitude of this situation, we are not going to belittle it. If anybody was going to appropriate money for a program of this kind, they should recognize that they were not dealing with peanuts. Reference was made to 20 million to 27 million acres. There is not that much acreage infested now. If you took the counties in which the infestation occurred and added it up, you would get 27 million acres; but since the program started there are about eighty counties in which fire ants occurred where they have been cleaned up. Some of those counties didn't require more than 5,000 acres to be treated. Others required 25,000. Now, we are hoping to hold that line. We don't want to have to do any more treating in those counties if we can help it—and we want to move forward. As we see it right now, we don't want to leave ants behind us. We want one application, plus possibly a one to two per cent clean-up back of that application to do the job wherever we are involved in it.

There are some problems, and we don't have all the answers yet, but if we can move forward in an orderly manner, leaving no ants behind us, I would rather come back about three or four years from now and make an educated guess as to what the opportunities of elimination are.

I would like to just comment here, too, on one other thing. You have seen and read Dr. Glasgow's report here. Its substance has been published a dozen times in the last year. In each instance there has been reference to livestock being killed by these treatments, livestock in Georgia, livestock in Texas. Blackleg killed the cattle in Texas. That was established by a number of veterinarians working together. It wasn't poison. Cold weather killed a lot of cattle in Georgia and Florida last winter. So far as we know, there have been only two calves that got into some of this material that have actually been poisoned to date, and they are not in a state that has been mentioned so far.

DR. GLASGOW: I would like to make one comment. I did mention livestock losses. I did not refer to livestock killed by insecticides.

DR. POPHAM: The inference is there.

DR. COTTAM: There is much that could be said on this subject and I shall forego a lot of thoughts that it is hard for me to retain to myself, but I shall ask a single simple question.

Dr. Glasgow mentioned the sugar cane borer and rice stink bug. I know he made reference to one or both of these, and I have seen reference to both of these in the paper. I should like to ask Dr. Glasgow, what relation do these high populations and these outbreaks have to the application of fire ant control?

DR. GLASGOW: Again you are getting into questions which are out of my field. I did talk this situation over with an entomologist and I was told that when questions came up concerning the sugar cane borer and the rice stink bug, it was not his place to state what had happened. Therefore I am doing this at the advice of an expert entomologist.

There is a published report in the *Sugar Cane Bulletin* for December of last year that gives the results of two surveys, and according to this survey there was a definite increase in the number of the sugar cane borers in areas treated with heptachlor versus those that were not. That is available for anyone who cares to see it.

I was also given some information on the rice stink bug. In tests which were made in treated versus untreated fields the probability or the chances of the heptachlor treatment increasing the rice stink bug is about 99 to one, so that it evidently did increase the rice stink bug.

DR. HAROLD PETERS [Georgia]: I am getting a little tired hearing about these comments that no cattle and no livestock are killed. It depends on who is reporting that and whom you want to believe. In Decatur County, Georgia, reputable veterinarians have certified that over 100 head of cattle and many other kinds of livestock, many kinds and many individuals of poultry, have been killed by fire ant control and certainly not by the supposed cold weather of the winter before last. I live in Georgia. I know a little bit about these things. I have been investigating them. I have talked to farmers in Alabama, who have had lots of cattle—one farmer had two cows, two calves and a number of chickens killed on one of his tenant farms. Another farmer lost a cow. In Texas three registered bulls and eleven calves have been killed. It just depends on whom you want to believe. Somebody is covering up, but I will tell you there are too many reputable veterinarians who have examined these animals, too many analyses have been made.

Another thing, Dr. Popham implies that before the fire ant program was begun, the Public Health Service and other agencies were taken into consultation. The truth of it is they didn't have a chance. They weren't even consulted. Dieldrin was first distributed by airplane based on research work done in Alabama by agricultural experiment people on two 30-acre plots. They have used the airplane now on about half a million acres. I certainly think it is time to get rid of the propaganda and to get real facts on some of this loss. It is a very bad thing, this broadcasting of chemicals which are not specific for the pest target.

DR. POPHAM: There is one comment I can't let stand.

We did consult the Public Health Service, Dr. Peters, before the first pound of chemical was applied. If you will come by my Washington office, I will call people in who participated in that and go over it again.

DISCUSSION LEADER ARANT: To my knowledge no agricultural experiment station recommends leaving livestock on areas while those areas are treated. In some of the research work done by the API Agricultural Experiment Station the livestock were left on the land. In the area treated at Camden, the cattle were left on the land. The chemicals were applied at the rate of 2 pounds of technical material per acre. These cattle were well-fed and in a high nutritional state. None of the animals was made ill or made sick in any manner by these treatments. We don't have any information about what might happen to half-starved animals. The animals were not harmed apparently. There was one horse killed by the material applied at Camden, Alabama.

CHAIRMAN DECKER: I am going to take one moment to try to clarify some things, not to correct or challenge anybody but to again try to bring some of these things together.

Dr. Haller mentioned insecticides in granules which go to the ground.

The lady called attention to the situation where during a spraying operation cows in pasture got DDT in the milk. But that was a spraying operation where most of the insecticide stays on the foliage and the vegetation. DDT is the most persistent of all the chlorinated hydrocarbons and has a rather high propensity for storage in fat or elimination in milk.

So they just weren't together, you see, on what they were thinking.

Animals do die of one cause or another during these programs. The only thing that I can add from our research is that we have studied this whole gamut of compounds as they pertain to livestock, particularly as they apply to dairy animals and in milk, and heptachlor has rather a low propensity for storage. We have fed cows, not what they might get in the fields a day or two, but for 18 consecutive weeks every day, 200 parts per million in their diet. They have produced heptachlor in the milk under those conditions, but the cows have been in normal health. They have been under veterinary supervision every day. One of them was bred early in the series and was carrying a calf at the end of the experiment. Let us not jump at the information presented quickly by either side.

PESTICIDE-WILDLIFE PROBLEMS AND RESEARCH NEEDS

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At the thirteenth North American Wildlife Conference, Kalmbach and Linduska (1948) presented a paper which dealt with the philosophy, needs, and hazards of controlling troublesome birds, mammals, and insects, and raised the question as to whether control, as then practiced, was itself in need of control. They pointed out that the only Federal regulation having a bearing on the problem was the "Federal Insecticide, Fungicide, and Rodenticide Act" (Pub. Law 104, 80th Congress). This Act concerns the registration and labeling of economic poisons moving in interstate commerce; its regulatory effect on the sale or use of economic poisons is limited.

To the relatively few chemical control agents in common use prior to World War II, including arsenicals, nicotine, rotenone, and pyrethrum, have been added hundreds of new insecticides, fungicides, herbicides, miticides, rodenticides, repellents, fumigants, and dessicants. The ones of most immediate concern to the most people are the insecticides. The majority of the new insecticides are chlorinated hydrocarbons such as DDT, methoxychlor, heptachlor, dieldrin, aldrin, and endrin; and organic phosphates including malathion, parathion, and TEPP. From a wholesale value of about $40,000,000 in 1940, basic chemical control materials increased to a level of $290,000,000 in 1956, and Fisher (1956) estimated that production would reach the wholesale value of $1,000,000,000 by 1975. Much of the 1940 production was applied by ground equipment to agricultural cropland while a considerable portion of the current output is applied by aircraft to wildlife habitat on marsh, agricultural, range, and forest lands.

Few people question the need for controlling injurious or nuisance insects and other pests. Were it not for insecticides and other chemical control materials, production of food and fiber and maintenance of our living standards at the current high levels would be impossible. Being poisons, however, these chemicals, if not applied with care, can be harmful to mammals, birds, fish, and other valuable wildlife resources. The benefits derived from a particular control program

[1]In preparing this paper the author made extensive use of material, both published and unpublished, provided by personnel of the Branch of Wildlife Research. He is especially indebted to Drs. James B. DeWitt and John L. George and Mr. Paul F. Springer for technical information on pesticides; to Drs. John W. Aldrich and Richard H. Manville for advice on the distribution and occurrence of certain birds and mammals; and to Walter Dykstra and Lucille F. and William H. Stickel for editorial comments.

should thus be viewed in light of the long-range public interest and the overall ecological effects.

All too little is known about the effects on wildlife, even of the most familiar chlorinated hydrocarbon, DDT, which has been under study by the U. S. Fish and Wildlife Service since 1945. Studies by this Service have included laboratory, small-scale study plot, or field tests and some follow-up observations of actual control operations. Much of the earlier work was done on forest lands in cooperation with the Forest Insect Investigations Division of the Bureau of Entomology and Plant Quarantine. Other agencies, Federal, State, and private, have made studies on various pesticide-wildlife problems, but, even so, many of the newer chemicals have not been investigated at all in relation to fish and wildlife.

SOME HIGHLIGHTS OF PESTICIDE-WILDLIFE RESEARCH FINDINGS

No attempt will be made here to review in detail the findings from individual studies made in this field. Fairly intensive appraisals of the pesticide problem in relation to fish and wildlife resources have been made by Rudd and Genelly (1956), George (1957) and others.

In general it can be stated that with DDT: (1) mammals, among the vertebrates, are least susceptible; birds are somewhat more sensitive, and cold-blooded animals such as amphibians and fishes are the most sensitive. Mollusks are highly resistant.

(2) Most aquatic animals are more susceptible than terrestrial forms.

(3) No large and immediate losses occur in forest populations of mammals, birds, and reptiles after a single application of one pound of DDT per acre.

(4) Applications of two or more pounds of DDT per acre are likely to have some effect on most vertebrate animals and dosages of five or more pounds per acre produce serious losses among most species, including mammals.

(5) Some mortality of fish and shellfish can be expected as a result of a single application of 0.2 pound or more of DDT per acre to water surfaces.

(6) Reproduction of penned quail and pheasants was reduced when the birds fed upon diets containing sublethal amounts of DDT, heptachlor, and dieldrin, the last two insecticides being 10 to 20 times more toxic than DDT.

As pointed out by Springer (1956) tests on laboratory animals indicate that, as a general rule, methoxychlor, TDE, BHC, chlorthion, and malathion are less harmful than DDT; heptachlor, aldrin, endrin, dieldrin, diazinon, EPN, parathion, and TEPP are more lethal than DDT; and, intermediate in their harmful effects on mammals, are lindane, toxaphene, and chlordane. Some of these materials, including parathion, chlordane, toxaphene, and BHC, were found to have a repellent effect on bobwhite quail when applied to their food. Studies by DeWitt (1955) indicated that young quail were more susceptible than adults to strobane, pheasants were more resistant than quail to aldrin and dieldrin, and female pheasants were more resistant than males to these compounds.

Also, according to Springer (1956), chlordane and methoxychlor are about in a class with DDT in their effects on fish while TDE and BHC are less toxic. In laboratory tests, golden shiners were most resistant, whereas bluegill sunfish, largemouth bass, and goldfish showed increasing susceptibility. Crabs, shrimps, and aquatic insects were even more susceptible than fish although clams, oysters, and snails appeared to be somewhat more resistant to most of these chemicals.

The type of carrier with which an insecticide is combined has a bearing on the effects of pesticide treatments on wildlife. Thus, in treatments of wetlands and water areas, emulsions, which mix with water and remain distributed in the water, are more dangerous to fish than dusts, wettable powders, and granules, which tend to settle to the bottom where they are not as readily available except to bottom feeders. Oil solutions, on the other hand, are dangerous to fish which feed at the surface of the water.

Observations of Dutch elm disease control operations have shown that when chemicals are applied by mist blowers there is less puddling of spray material and less bird mortality than when poisons are applied in droplet form.

Poisoning of wild birds and mammals from the present-day use of most herbicides and fungicides appears to be of relatively minor consequence (Springer 1957). Applications of DNBP and DNC (dinitro compounds) have been reported to kill rabbits, pheasants, and song birds (Edson 1954) and the dangers of sodium arsenite to warm-blooded animals, particularly mammals, have been demonstrated. Also, a few herbicides, including chlorinated benzines, the aromatic solvents, dinitro compounds, and mercury compounds present hazards to aquatic life if the chemicals enter ponds and streams.

Herbicides can have either beneficial or detrimental effects on fish and wildlife, depending upon the manner and extent to which they are used. It is a field in which as explained by Allen (1953) we have only begun to explore and in which, "Once again, operations are far ahead of investigations. . . . If we are interested in having game and other creatures considered in large herbicide operations, it is time now to get busy and develop a basis of workable techniques on which realistic recommendations can be made to those who are doing the job.''

Rodenticides, as the name implies, kill rodents. When used in and around buildings for the control of commensal rodents, they constitute little hazard to free-ranging wild animals; when used to control field rodents or predators, every precaution must be employed to prevent unnecessary loss of valuable wildlife species. Zinc phosphide-treated grain bait is used widely in control of field rodents. Sodium fluoroacetate (compound 1080) is used for both domestic and field rodent control and for coyotes and occasionally other carnivores. Its toxicity is high, and only qualified personel may handle it. Use of colored baits in applying either zinc phosphide or 1080 serves as warning to human beings and as a deterrent to birds.

APPLICATION OF PESTICIDE-WILDLIFE RESEARCH FINDINGS

Pesticide-wildlife studies and observations on the immediate kill of fish and wildlife following operational use of insecticides have been sufficiently extensive to cause concern among sportsmen, conservationists, and, indeed, the control people themselves. In 2000 acres of Florida east-coast tidal marsh treated with dieldrin pellets that were air-disseminated at one pound per acre to destroy sandfly *(Culicoides)* larvae, the fish kill was substantially complete (Harrington and Bidlingmayer, 1958). Extensive fish kills from light dosages of DDT were reported in the Miramichi River drainage in New Brunswick, Canada (Kerswill and Elson, 1955). More recently, observations made in connection with the program for eradication of the imported fire ant (*Solenopis saevissima richteri*) in the Southeast have shown heavy losses of bobwhite quail, song birds, rabbits, and other terrestrial animals.

Spectacular as some of these immediate losses may appear, biologists recognize the resiliency of most wildlife populations and their ability to sustain losses, yet bounce back and repopulate depleted areas—this assuming that the residual nature of some of the pesticides and the indirect effects of the poisons, either on reproduction or on food chain organisms, are not such as to prevent such repopulation phenomena. The growing public awareness of these hazards is reflected in the enactment of Public Law 85-582 of August 1, 1958. This law directed the Secretary of the Interior to undertake continuing studies of the effects of insecticides, herbicides, fungicides, and other pesticides, upon fish and wildlife and authorized appropriation of $280,000 per annum to carry out such work.

Before reviewing some of the needed research, however, let us list some of the guidelines or precautionary measures that have been indicated by research already accomplished or called for by good conservation which has, as a major objective, the accomplishment of the most good for the most people over a long period of time. Most conservationists recognize the need for pest control and realize that if a forest is saved from destruction by insects through application of insecticides, forest habitat is preserved for certain species of wildlife; but conservationists also want to be assured that pesticides are used only when and where necessary and with the minimum detrimental effects on fish and wildlife.

Cope and Springer (1958) and Stickel and Springer (1957) have suggested some fish and wildlife protective measures primarily as related to forest insect aerial control operations. These are summarized here in slightly different form:

(1) Be sure there is a real need for pesticide use.
(2) Treat the minimum possible area to accomplish the job.
(3) Consult with competent wildlife biologists before starting insecticidal programs.
(4) Select the chemical that will be the least dangerous to fish and wildlife and still do the job. Apply chemicals strictly according to label instructions.
(5) Consider the carrier in which the pesticide is mixed as some carriers are toxic to wildlife.
(6) When an insecticide is used in an emulsion, the quantity should be reduced because of the greater toxicity of this formulation to aquatic animals.
(7) Use minimum dosages and minimum number of applications. Increased rates of application or extra treatments "for good measure" may not greatly increase insect control and do increase hazard to wildlife.
(8) Plan the time of treatment to reduce hazards. Thus, if possible, the main spring migration and nesting periods of birds should be avoided. Also, insect infestations should be treated before they reach upper drainage areas or before they cover large acreages so that, if damage to wildlife does occur, repopulation can proceed more quickly.
(9) Careful ground-to-plane control should be provided to restrict application to intended areas, to ensure even coverage and to prevent local overdosage.
(10) In forested areas, dosages should not exceed one pound of DDT or its equivalent per acre. Direct applications to streams, rivers, ponds and lakes, or to sites where rapid leaching into nearby aquatic areas might occur, should be avoided unless the rate of application is less than the toxicity equivalent to

0.2 pounds of DDT in oil solution per acre.

(11) Applications around the edge of lakes should be made with small planes and when wind velocity is low. Where possible, ground equipment should be used in such situations.

(12) Pilots should avoid turns over streams, rivers, and lakes or the use of these areas as boundaries for control operations.

(13) Care should be taken to avoid contamination of streams and ponds through filling or rinsing spray equipment in them.

(14) In so far as possible prevent puddling of insecticidal solutions where birds and other animals may drink and bathe. Mist blowers and foggers cause little or no puddling as compared to hydraulic sprayers.

(15) Where applicable, cover fish ponds and bird baths.

NEED FOR COOPERATIVE EFFORT

There must be team work in approaching pest control problems and in developing methods for keeping to a minimum the hazards to valuable fish and wildlife. Biologists working on pesticide-wildlife problems must report the facts as revealed by their research and exercise due caution in extrapolating findings obtained on small study areas to larger areas. Chemists engaged in analytical and toxicological work on chemical pesticides should get together and make sure their techniques are correct and standardized in such a manner that their deductions can be compared and interpreted more readily.

There is need for more cooperation among entomologists, chemical manufacturers, wildlife biologists, and control personnel in formulating chemicals that are more specific in their control. These specialists, by working together, should progress faster in the development and testing of safer dosages and methods of pesticide application than would otherwise be possible. Some progress has been made along this line in the substitution of the less toxic, albeit more expensive, methoxychlor for DDT, and the use of mist blower spraying equipment in place of hydraulic sprayers, in Dutch elm disease treatment. Recent reports on the relatively low toxicity of Sevin to fish and wildlife have been encouraging, also.

Some manufacturers of pesticides have worked with State and Federal agencies on these problems and have hired research personnel of their own to conduct tests on overall biological effects; others have taken little responsibility beyond the manufacture and sale of chemicals. Recently preliminary plans were made for an intensive, long-term ecological study of the fire ant program in the Southeast. It is this type of team study in which the entomologist, the chemist, soils expert, fish and wildlife biologists, and control operators work together that should provide the facts needed to resolve some of our difficulties.

The flow of information between the control agencies and the conservation agencies also is very important. The control people should keep the conservationists and the fish and wildlife research biologists informed of when and where they are going to spray, what chemicals are to be used, and what dosages and application techniques are planned. The conservation agencies should keep the control agencies advised of their findings and provide them with information on the abundance and distribution of fish and wildlife. Of particular importance in this respect are those species which now exist in very small numbers or are restricted to local areas subject to pesticide treatment and, hence, in possible danger of extirpation.

MAJOR INSECT CONTROL OPERATION AREAS

Close liaison between the U. S. Departments of Agriculture and Interior is essential on pest control matters. On the basis of information provided by the Department of Agriculture some of the major insect control operation areas may be defined in general terms. At the same time some of the birds and mammals that are endemic to these areas or are of special interest for other reasons may be mentioned. It must be understood that these are only samples of the species or subspecies occurring in a general control region and it can not be stated with certainty that a given species or subspecies will be subjected to a pesticide until the specific areas to be treated are known. Having such information well in advance of a wildlife study is invaluable.

1. Imported Fire Ant Area

Of the major problem areas the one most talked about at this meeting is the imported fire ant area, including parts of nine southeastern States. Here we are concerned especially about the bobwhite quail, wild turkey, woodcock, cottontail rabbit and other game species such as Atwater's prairie chicken, if present within the area proposed for treatment. Some ornithologists still consider the ivory-billed woodpecker extant within the overall confines of the fire ant area.

2. Gypsy Moth Area

This large area extending from southern Maine and eastern New York southward to Pennsylvania and New Jersey includes the range of the New England bobwhite *(Colinus virginianus marilandicus);* and portions of the ranges of the eastern house wren *(Troglodytes aedon aedon)* the eastern warbling vireo *(Vireo gilvus gilvus),* the

Baltimore oriole (*Icterus galbula*), and the subspecies of woodchuck (*Marmota monax preblorum*). Many other fish and wildlife species of interest could be mentioned.

3. Elm Bark Beetle Area

The major elm bark beetle area extends in a broad belt from eastern Iowa and southern Wisconsin to Massachusetts and northern Virginia. As in the case of the gypsy moth area, this region supports a high human population, and bark beetle control efforts, which cause some readily observable mortality of robins and other wildlife, result in demands for something to be done about the situation. Among the other interesting problems posed in this particular area is the relationship of the bark beetle (Dutch elm disease) control program to the status of two birds which are primarily elm tree nesters, the Baltimore oriole and the eastern warbling vireo. What is happening or will happen to these species if the elms are treated with toxic materials; what will happen to them if the elms die?

4. Other Forest Insects

In northern Minnesota there is an infestation of tent caterpillars; in northern Maine the spruce budworm is a recurring problem; but a much larger area of mostly mountainous forest lands extending from northern New Mexico through Colorado, northwest Utah, western Wyoming and Montana, eastern Oregon, and northern Idaho, is infested with bark beetles, spruce budworms, and other forest insects. In this extensive area are found many game birds including the Rocky Mountain blue grouse (*Dendragapus obscurus*) and spruce grouse (*Canachites canadensis*), the grizzly bear (*Ursus horribilis*) and moose (*Alces americana*) which, of course, occur also in Canada and Alaska, and many smaller mammals among which are the Uinta ground squirrel (*Citellus armatus*), red-tailed chipmunk (*Eutamias ruficaudus*) and Uinta chipmunk (*Eutamias umbrinus*). Game administrators will be particularly interested in the effects of forest insect control on populations of deer and elk, as well as on fish and valuable fur animals.

5. Grasshoppers

A survey planned and performed by the Plant Pest Control Division, Agricultural Research Service of the U. S. Department of Agriculture in cooperation with various State agencies during the late summer and fall of 1958 (U.S.D.A. release of Nov. 20, 1958) indicated more than twenty-two and one-half million acres of croplands in 15 western and midwestern States had infestations of grasshoppers. The major problem area extends from northern Texas and western Oklahoma northward through the eastern half of Colorado, western Nebraska, and Wyoming to northern Montana, with other extensive infestations in California.

In this vast area we find such game species as quail, pheasants, waterfowl, sage hens, sharp-tailed grouse, lesser prairie chickens, Hungarian partridge, antelope and cottontail rabbits. Among the non-game animals are the white-rumped loggerhead shrike *(Lanius ludovicianus excubitorides)*, lark bunting *(Calamospiza melanocorys)*, Baird's sparrow *(Ammodramus bairdii)*, McCown's longspur *(Rhynchophanes mccownii)*, black-footed ferret *(Mustela nigripes)*, and Plains harvest mouse *(Reithrodontomys montanus albescens)*. Little is known about some of these species but all available evidence would indicate that, considering the present status of the lesser prairie chicken and black-footed ferret, every effort should be taken to protect them from losses due to insecticide applications.

6. Other Control Areas

Extensive areas of marshes, both fresh-water and salt, inland and coastal, are sprayed every year with attendant hazards to wildlife, fish, and other aquatic organisms. In peninsular areas such as Florida, or certain island situations, there is likely to be a relatively high percentage of endemic forms which deserve close observation in connection with extensive pest control operations. In Florida, for example, among the birds, we find the Florida Everglades kite *(Rostrhamus sociabilis plumbeus)*, limpkin *(Aramus guarauna)*, two races of Florida clapper rails *(Rallus longirostris)* and the mangrove cuckoo *(Coccyzus minor)*. Among the Florida mammals that might be subjected to insecticide applications are the Florida water rat *(Neofiber alleni)*, two subspecies of the eastern mole *(Scalopus aquaticus anastasae* and *S. a. parvus)*, the cotton mouse *(Peromyscus gossypinus palmarius)*, two subspecies of rice rat *(Oryzomys palustris coloratus* and *O. p. notator)*, the marsh rabbit *(Sylvilagus palustris paludicola)* and the white-tailed deer *(Odocoileus virgianus clavium)*.

Another program of somewhat different type is the extensive use of herbicides in forest and range management. The hardwood control being practiced in the pine forests of the South requires further evaluation with respect to the overall effects on such species as turkey, deer, quail, and squirrels. Brush control programs in central and western Texas require similar assessment. Problems of similar magnitude and complexity are arising in the arid Southwest and Intermountain regions where there is growing agitation by water users for conversion of woody cover to grass on mountain watersheds so as to reduce transpirational losses and increase stream flow for down-stream irrigation. Elimination of stream-course trees and shrubs is likewise advocated. Wildlife research should be geared to predict the consequences.

CURRENT PESTICIDE-WILDLIFE RESEARCH

The U. S. Fish and Wildlife Service started investigations in 1945 on the effects of insecticides on wildlife. By fiscal year 1958 the total budget for this work in the Bureau of Sport Fisheries and Wildlife had reached $56,000. In fiscal year 1959 the budget for this activity was increased to $181,000 of which $136,000 was allotted for research on bird and mammal investigations and $45,000 to initiate the program in the Branch of Fishery Research. Facilities at the Patuxent Research Refuge and the Denver Wildlife Research Laboratory are being expanded and the latter will accommodate both wildlife and fisheries-pesticide studies.

Stated briefly the pesticides program of the Bureau of Sport Fisheries and Wildlife includes:

(1) Studies to determine acute and chronic toxicities, mode of entry, and sublethal effects of pesticides not previously evaluated.

(2) Chemical analyses of plant and animal tissues, foods, and soils to determine the presence of pesticides and measure toxic effects in wildlife habitat.

(3) Appraisal of immediate and long-range effects of insect control operations on birds and mammals.

(4) Compilation and dissemination of information on production, use, and toxicity of pesticides.

(5) Limited study of the effects of herbicides on wildlife.

Efforts are being made to expand the fire ant control studies with particular reference to effects on the woodcock *(Philohela minor)* and to initiate studies of grasshopper and forest insect control in relation to wildlife. Contracts on fire ant studies also are in effect with Louisiana State University and Alabama Polytechnic Institute.

At the time this paper was written other pesticide-wildlife studies known to the author included investigations at three or four universities, four Pittman-Robertson projects dealing primarily with direct effects of pesticides or economic poisons on wildlife, and 10 Federal Aid projects on the use of herbicides in relation to habitat. It is my understanding that the National Audubon Society is initiating a project on the possible effects of pesticides on the bald eagle and that books on pesticide-wildlife problems are in preparation by Miss Rachel Carson and Mr. Robert L. Rudd, the latter under sponsorship of the Conservation Foundation. Still other studies dealing with pesticide-wildlife (or fish) relations are being conducted by the U. S. Department of Health, Education and Welfare. Undoubtedly there are other studies of which we are unaware, and one of the needs faced by workers in this field is a current listing of projects so those concerned will know who is doing what, when, where, and why.

PESTICIDE-WILDLIFE RESEARCH NEEDS

Fundamental to a more adequate appreciation and understanding of pesticide-wildlife relations are four primary needs. Assuming that the necessary funds, equipment, manpower, and cooperation can be obtained we need to:

(1) Develop methods and conduct studies to determine the acute and chronic toxicities, mode of entry, and sublethal effects of pesticides on various kinds of animals according to their sex and age.

(2) Develop methods for determining and confirming the presence of lethal quantities of pesticides in animals suspected of having died as a result of chemical pesticide applications.

(3) Compile information on pesticide types, production, application methods, dosage rates, and areas where pesticides are used.

(4) Appraise, in the field, under operational conditions, the immediate and long-range, the direct and indirect effects of pesticides on fish and wildlife, both game and non-game.

Let us examine these four basic needs more closely. What procedures are involved in determining the toxicities of pesticides to wildlife? How long does it take? How expensive is it? (To give you some idea about this, one commercial laboratory gave an estimate of $450 to analyze one specimen for endrin content). A larger number of samples could have been analyzed at less cost per specimen but how many specimens must you analyze before you can be certain you are right? How do the poisons affect the fish or the wildlife? How does it get into them—through the skin? Through the mouth? Do bobwhite quail pick up heptachlor granules as grit? Do rabbits consume poison clinging to vegetation or lick it off their feet? How much does it take to kill pheasants or make them sick, or affect their reproduction? Do the poisons affect young and old, or male or female alike? What sort of standards should one use in indicating toxicity of a given substance? Does toxicity vary with species?

Look at item number two. How do you determine and confirm the presence of lethal quantities of a certain chemical in an animal suspected of having died as a result of chemical pesticide poisoning? Do you use the same technique for a sparrow as you do for a deer? How can you be sure that the presence of a poison in a specimen was the cause of death?

The third need listed—that of compiling information on pesticide types, production, application, dosage rates, and areas where used—is obvious, and has been treated in some detail elsewhere in this paper. It is a continuing need, however, and one requiring the close cooperation of research and operating personnel and of the chemical manufacturers. These manufacturers should be apprised of any information they could use in formulating compounds that would be less toxic to valuable species and still effective as pesticides.

The field appraisal of the effects of pesticide operations on fish and wildlife is, in many respects, the most difficult to accomplish and, at the same time, the most vitally needed. It is in the fields and streams, the ponds, woods and marshes that the fish and wildlife losses occur and where the various effects of pesticides as applied under varying operational conditions need be determined. Study areas must be numerous enough and large enough to be representative of the whole area which is treated. This requires good statistical designing of projects and familiarity with the range, movements, and characteristics of the wildlife species concerned.

Animals that consume pesticide-treated food under captive conditions may not consume like amounts under field conditions. Complex food chains and other ecological factors exist in nature that can not be duplicated in the laboratory or in small pens. A rabbit weakened or dead as a result of a grasshopper control program may be taken by a coyote or a vulture before it is observed by a wildlife investigator. Many of the smaller birds disappear rapidly following death. Movement of animals out of or into a study area immediately after treatment may affect censusing. These and other factors complicate matters for the research biologist and render interpretation of findings very difficult.

Among the field studies needed are investigations of:

(a) Ability of wildlife populations to sustain losses due to pesticides, and then to repopulate depleted areas. From how far will wildlife populations move into depleted areas and how long will it take? Will the residual pesticides on or in the soil continue to cause fish and wildlife losses and, if so, for how long? How do the losses of game animals affect the supply left for the hunter?

(b) Effects of pesticides, including herbicides, on wildlife cover and food plants and on animals such as earthworms in which chemical pesticides may be stored without killing them. How important are these food chain organisms as secondary sources of poison to mammals and birds? To what extent do herbicides have direct as well as indirect effects on animals? There seems little doubt that vegetational control through use of herbicides will affect both fish and wildlife because of habitat changes. Are we able to provide acceptable guidelines for preserving fish and wildlife resources in connection with extensive programs planned or underway? The answer seems obvious.

(c) Migratory birds subject to multiple dosages of pesticides. It would seem that migratory birds might be exposed to several areas treated with pesticides of the same or different types during the course of a year. Studies are needed to determine whether this happens and, if so, to evaluate the effects on birds, for example, which winter in the fire ant area and breed in an area sprayed for gypsy moth or spruce budworm.

(d) Mosquito control operations, with especial reference to the bald eagle, fish and other aquatic life. As pointed out earlier many aquatic animals are more sensitive to DDT and some of the other insecticides than terrestrial forms. More should be learned regarding the extent of such losses following chemical control of mosquitos. Considerable concern has been expressed about the apparent decline, especially in the East, in numbers of bald eagles and their decreased reproduction. The possibility that they are being affected as a result of consuming fish which have died from insecticides used in mosquito control should be investigated.

(e) Forest insect and disease control programs including Dutch elm treatment as related to robins and other song birds. Mehner and Wallace (1959) and Barker (1958) have reported losses of robins in suburban areas in the north central part of the United States following spraying of bark beetles in Dutch elm disease programs. Gypsy moth, spruce budworm, and other forest insect pests now infest vast areas. It is essential that studies be conducted concurrently with the extensive control operations to evaluate effects on fish and wildlife and to evolve methods for keeping losses of these resources to a minimum.

(f) Rodent control programs including the use of endrin in orchard mouse control. Some of the rodenticides are more toxic to mammals than are some of the common insecticides. Extreme care must be used in applying them in the field in order to avoid losses to valuable wildlife. Endrin, although it is registered primarily as an insecticide, has been found effective in killing mice and is being used to an increasing extent by orchardists for this purpose. Often it is used at the rate of about two pounds per acre as a rodenticide. It is about 100 times more toxic than equal amounts of DDT to quail, and is extremely toxic to fish. Hence, there is urgent need to evaluate its effect on rabbits, quail, song birds, and other valuable wildlife frequenting orchards, and to note the effects of endrin run-off in nearby streams and ponds.

(g) Grasshopper control programs. Grasshoppers and Mormon crickets infest vast areas of western rangeland, grain fields, and roadside grasses. Little is known about loss of fish or wildlife caused by the extensive programs to control these pests. Unlike forested areas where the tree foliage may intercept most of the aerially applied spray material before it hits the ground, much of the insecticide reaches the ground in grasshopper control operations. Here again we are interested in both direct and indirect effects on game and non-game fish and wildlife.

(h) Other chemical control programs. Among such programs are those in which miticides, fumigants, fungicides, and nematocides are used. We know little about the effects of these on wildlife. It is time for us to learn about them.

CONCLUSION

This paper points out the tremendous growth of chemical pesticide industry since 1940; reviews some of the findings from the relatively limited pesticide-wildlife research which has been conducted, especially as pertaining to effects of DDT on fish and wildlife; cites some of the more spectacular losses of fish and wildlife resulting from pesticide applications; lists some guidelines for use as fish and wildlife protective measures during spraying operations; describes some of the major problem areas and gives samples of endemic or other species of birds and mammals of special interest that may be endangered; briefly reviews current pesticide-wildlife research; and points out additional research needs.

Throughout the paper, the need for cooperation is stressed. To develop a better understanding and appreciation of the complex pesticide-wildlife relationships and to accomplish pest control with a minimum of fish and wildlife losses, will require greatly increased cooperation. There must be cooperation on the part of the Federal, State, and private agencies concerned, and the coordinated effort of landowners, control operators, research personnel and administrators. There must be a better exchange of information among entomologists, fish and wildlife biologists, chemists, chemical manufacturing concerns, and operational control personnel. There will always be conflicting opinions with respect to control operations because of divergent interests of people, even in the same community. Alarmism and emotionalism will not resolve these conflicts. We must get the facts and base our actions on these facts.

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DISCUSSION

MR. BELT [New York]: Someone should point out that a great deal has been said about what we do not know about the program. Therefore no large-scale program should be carried out until the answers are known. This mass spraying should be discontinued until we know some of the answers.

MR. JOHN BAKER: It seems to me that there is a general need of less post-mortem thinking and more emphasis on saving the living and less on analyzing the dead.

We invite the chemical industry to join with us in putting a stop, for at least the time being, to the broadcasting over great areas of toxic chemicals. We also ask them to join with us in obtaining a research program that is adequate to meet the needs of this situation. We know that the leaders of that industry are leading citizens who are highly intelligent, that they appreciate the value of public relations, that they are greatly concerned at the present time at the deterioration of public relations because of their identification with the massive broadcasting of highly toxic chemicals, including petroleum distillates usually used as carriers.

Now, as to the research program, we are never going to get very far fiddling around with $280,000 a year. You have heard of the complexity of the research that needs to be done. It covers a wide field of many different chemicals in different solutions and carriers. It covers the effects on a great many different things, including a vast number of different animals and soil organisms and to find out what the effects of each one of those in different quantities and solutions is on each of those animals is going to require a great deal of effective research and the money to finance it and we have been recommending that there be $25 million a year put into this research in order that the job may get done before we are all dead, or our children are.

Now, $25 million may seem like a good deal of money, but the annual sales at retail today of these chemicals for insecticide purposes is around $500 million, and it has been estimated that in another fifteen years it will reach a retail volume of $2 billion. Therefore, spending $25 million a year for a while to get the answers seems to me a cheap percentage of the total potential sales volume for the chemical industry, and I sincerely hope that the leaders of the industry will join with the conservationists, will recognize the importance of public good will in this matter and will recognize the fact that research statistics, while very important, are not going to mean much to the general public. They are going to be concerned with fear as to their own health, that of their children and their grandchildren, and whether they are going to be unable to reproduce. That is the kind of thing that people are going to be afraid of and no amount of defensive statistics from research are going to change that trend in my opinion.

MR. JOSEPH S. LARSON [Wildlife Conservation Incorporated, Boston, Massachusetts]: The last speaker has dwelt on two things, the need for research and the need to cease widespread spraying now until research gives us the answers. Most of us in this room know how long we would have to wait before we got the answers that the former speaker is talking about. What is the period of time that he would suggest we do not spray?

Coming from Massachusetts I can only remember the classic example there—you may remember, perhaps, that our State is responsible for the gypsy moth. When an uninformed public and an uninformed Legislature ceased control operations in Massachusetts the gypsy moth spread. This ending of field research work that was going on at the time, was nearing the point when the gypsy moth might have been eradicated, although perhaps, eradication is an ill-chosen word.

MR. BAKER: I just want to clear up one point. The gentleman said that my position was in opposition to all spraying. I didn't say that. I said our position was to stop the massive spraying over wide areas of highly toxic chemicals. I am not talking about spraying gardens, just this massive spraying from the air over great acreages, until we find out whether or not doing so is seriously damaging to people or livestock, wildlife or soil organisms.

CHEMICAL REPELLENTS FOR THE CONTROL OF MAMMAL DAMAGE TO PLANTS

JEROME F. BESSER AND JACK F. WELCH

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Damage to silvicultural and agricultural crops by wild mammals, ranging from small rodents to big game, is a serious problem in many regions of the United States and Canada (Eadie, 1954; and others). Similar damage is also prevalent in Europe (Symposium, 1957; Church *et al.*, 1953), Australia (Ratcliffe, 1951) and other continents.

Farm and forest interests in the United States are becoming more aware of wildlife damage. Lawrence (1958) calculated that the loss to wildlife of Douglas-fir growing stock on tree farms of the Weyerhaeuser Timber Company for 1956 amounted to $875,000; and private timber interests believe that if wildlife damage to timber in the Douglas-fir region of the Northwest could be accurately measured it would total 12 to 15 million dollars annually. In the agricultural field, Pasto and Thomas (1955), in a survey of two Pennsylvania counties in 1951, reported that $189,000 in crops were lost to deer alone, and this did not include forest losses. These are striking examples of damage by wildlife.

The magnitude of crop losses can be reduced by better management of populations of game species, creation of less favorable habitats for less desirable species, and improvement of reductional control methods for pest species. However, it often may be easier and more economical to protect the plant and thus control the damage rather than the animal. This frequently can be accomplished through use of non-toxic chemical repellents. Control of crop damage through use of repellent sprays offers a means of making high populations of game animals more compatible with existing agrarian practices and, in some cases, may serve as a substitute or supplement for reductional control without hazard to beneficial species.

During the past decade, the wildlife research laboratories of the Bureau of Sport Fisheries and Wildlife at Patuxent and Denver have appraised more than 7,000 chemicals in an effort to develop a repellent treatment that is safe, effective, and economical for protecting textile, paper and plastic products from damage by commensal rodents. This work has been financed by the U. S. Quartermaster Corps. In these studies, it was found that compounds containing nitrogen, sulfur, and halides, or combinations of these elements, were the most active repellents (Bellack et al., 1953; Welch, 1954).

Utilizing this information, the Denver Laboratory undertook the task of determining the usefulness of several active commensal rodent repellents for preventing damage by field mammals.

FORMULATIONS AND TEST METHODS

The studies reported in this paper chiefly concern three specific formulations that are now available commercially. The active ingredients of these are trinitrobenzene-aniline (TNB-A), zinc dimethyl dithio carbamate cyclohexylamine complex (ZAC), and tetramethyl thiuram disulfide (TMTD). Hereafter, the abbreviations will be used. Both ZAC and TMTD were formulated as aqueous suspensions containing 10 per cent of the active ingredient, 10 per cent of an acrylic resin adhesive (Rhoplex AC-33), and small amounts of suitable thickening, defoaming, and dispersing additives.[1] TNB-A was prepared as a solution containing 5 per cent of this chemical, 10 per cent mixed biphenyl chloride resins as the adhesive, and an organic solvent.[2] All percentages are computed on a dry solids basis.

In experiments, these repellents were applied with 1-gallon capacity sprayers. Young woody plants were most frequently used in tests, chiefly because of the relative ease in determining differences in damage between treated and untreated plants. The per cent effectiveness or reduction in damage of treatments was derived from the formula:

$$\frac{\%\text{ untreated plants damaged} - \%\text{ treated plants damaged}}{\%\text{ untreated plants damaged}} = \%\text{ effectiveness}$$

Examples of the effectiveness of repellents in preventing damage by several species of field mammals follow. In many cases, data are taken from detailed progress and special reports in the files of the Denver Wildlife Research Laboratory, and it is regretted that formal publications are not available so that personnel involved in these studies would receive complete credit.

REPELLENTS FOR RABBITS AND HARES

A 3-year study (1953-56) in western Washington demonstrated that ZAC and TMTD reduced damage by varying hares *(Lepus washingtoni)* to newly-planted Douglas-fir *(Pseudotsuga menziesii)* seedlings by 82 per cent. TNB-A was slightly more effective but sometimes burned the foliage of seedlings. Clipping of untreated

[1]The ZAC formulation is available as Improved Z.I.P. from Panogen Company, Ringwood, Illinois; the TMTD formulation is obtainable as Selco TMTD-Rhoplex Rabbit and Deer Repellent Concentrate from Selco Supply Company, Eaton, Colorado.

[2]The TNB-A formulation is available as Ringwood Repellent from the Panogen Company.

seedlings on test plots by hares averaged 77, 87, and 53 per cent during the 3 years. Treatments were applied at the rate of 1 gallon per 2,000 seedlings in nursery beds before planting. This technique of protecting trees by repellent sprays has been adopted by several nurseries in Washington, and at present most of the Douglas-fir seedlings planted in the Northwest are given protection from hare damage the first dormant season.

Re-treatment of seedlings in the field also has been tried with some success. On the Capital State Forest in Washington in 1956, Douglas-fir seedlings, which had been protected by repellents the first dormant season, suffered 63 per cent clipping by hares the second year. Re-treatment with ZAC resulted in an 82 per cent decrease in this type of damage.

Krefting (1958) reported that repellents were effective in preventing damage in Minnesota. He applied ZAC and TMTD to black and white spruce *(Picea mariana* and *P. glauca)* plantings, and found that slightly more than half of the untreated spruce were clipped by varying hares *(L. americanus)* compared to less than 2 per cent of the treated spruce.

Trees that are larger than 1 inch in basal diameter are easier to protect from rabbits and hares than smaller trees. Young conifers are often destroyed by a single bite, whereas larger deciduous trees must be girdled before the tree is lost. In our studies, repellents were highly efficient in protecting plantings of fast-growing hardwoods.

In enclosure studies with cottontails (transplanted *Sylvilagus floridanus*) at Denver, TNB-A, ZAC, and TMTD provided complete protection to Chinese elms *(Ulmus pumila)* that were larger than one-half inch caliper, over an entire 6-month dormant season. In the same test all untreated elms were girdled within 2 weeks. These treatments, however, were only 68-90 per cent effective in protecting sandcherries *(Prunus besseyi)*, crabapples *(P. americana)*, and hackberries *(Celtis occidentalis)* that were less than one-half inch caliper and could be severed by rabbits with a single bite.

Excellent field results were obtained with TNB-A, ZAC, and TMTD in protecting deciduous trees from damage by cottontails and jackrabbits. These repellents have provided satisfactory protection to all species of deciduous trees tested in shelterbelt and game-cover plantings in South Dakota, in game-cover plantings in Wisconsin, and in orchards in Colorado. Eighty-two per cent protection was the lowest recorded at any site for any treatment.

In the course of a deer repellent study in an orchard in western Colorado, approximately 500 tags were attached to untreated terminals of apple trees, 4 feet tall. During deep snows, jackrabbits removed an average of slightly more than 4 inches from the untreated terminals, while none of the terminals treated with one-fifth of the standard concentration of TMTD were clipped.

The effectiveness of TNB-A, ZAC, and TMTD for protecting trees from rabbits and hares has been verified by research workers in other regions. Goldie (1955) in Ontario reported that TNB-A was the most repellent and long-lasting of 56 materials that he tested on apple rootstocks with captive European hares *(L. europeaus)*. He found TMTD and ZAC only slightly less effective. White *et al.* (1956) reported that TNB-A was the most effective repellent of 10 widely-advocated preparations for protecting apple trees against cottontails *(S. floridanus)* in Pennsylvania. Hayne and Cardinell (1958) reported that formulations containing TNB-A, ZAC, and TMTD were highly effective in protecting apple shoots from captive cottontails in Michigan.

REPELLENTS FOR DEER

The utility of Goodrite ZIP (ZAC in polyethylene polysulfide adhesive) in preventing summer deer damage to truck crops and orchard trees has been reported by Powell (1949), Boyce (1950), and others. To protect dormant plants, it was necessary to re-treat with ZIP several times during the season, as films flaked rapidly after a short period of exposure. Poor weathering of ZIP films was caused by an insufficient amount of adhesive in the formulation, but to increase the adhesive to the proper proportion for dormant-season protection of plants would have doubled the cost of the product. Our experiments with less expensive adhesives led to the development of the ZAC-Rhoplex formulation that has provided adequate weathering up to 1 year after treatment.

The effectiveness of ZAC and TMTD in protecting trees from dormant season deer damage has varied widely in different regions, as illustrated by these examples:

In southern Arkansas, ZAC provided complete protection to loblolly pine *(Pinus taeda)* seedlings from browsing by white-tailed deer over a 3-month period, whereas in northern Minnesota, Krefting *(op. cit.)* found that the same repellent reduced damage by white-tailed deer to jack pine *(P. banksiana)* seedlings by only 42 per cent over a 7-month period. Deer browsed 53 per cent of the untreated seedlings in the Arkansas test and 86 per cent of untreated seedlings in the Minnesota test.

ZAC and TMTD reduced browsing of ponderosa pine *(P. ponderosa)* seedlings by mule deer by 73 per cent at three sites in central Oregon, but these same repellents afforded little protection to Douglas-fir seedlings from browsing by black-tailed deer in western Washington. Deer browsed 65 per cent of untreated seedlings in the Oregon tests and 78 per cent of untreated seedlings in the Washington tests.

In 1957, entire apple trees in western Colorado orchards were treated with ZAC, with no special attention given to treatment of terminal buds. This treatment reduced deer browsing of the terminals by 76 per cent after 3 months, but only 38 per cent after 6 months. In 1958, in the same orchards, only the distal 6-10 inches of the terminals were treated with ZAC, and this reduced damage by 73 per cent over a 6-month period. Deer browsed 64 per cent of untreated terminals in 1957, but only 27 per cent in 1958; hence, the better protection in 1958 could be explained by less deer pressure. However, thorough treatment of only the terminal bud area was much cheaper and may prove more effective than treating the entire tree. In these tests TMTD was less effective than ZAC. Neither repellent protected trees against antler damage.

These examples indicate that the effectiveness of ZAC and TMTD varies with the length of test period, species of tree, thoroughness of treatment, and amount of deer pressure. The variance in reaction of subspecies or even individual deer to repellents, however, may outweigh any of these factors. Eadie *(op. cit.)* in his review of repellents for cottontails observed that a chemical effective in protecting trees in one region may not be equally effective in all regions or with all species of *Sylvilagus*. Spencer (1958) reported that the rejection or acceptance of tree seeds coated with various chemicals varied widely among species, sub-species, and individual white-footed deer mice *(Peromyscus)*. Our experiments indicate a similar variation in reaction of deer to repellents. It appears that persons confronted by deer damage problems, which could be solved by use of an effective repellent, should give ZAC or TMTD a trial under their local conditions.

REPELLENTS FOR OTHER WILD MAMMALS

Small-scale studies of repellents for preventing damage by several other species of wild mammals have been conducted or are in progress.

TMTD was 80 per cent effective in protecing Douglas-fir seedlings from damage by meadow mice in a planting in Colorado and 74 per cent effective in a planting in Washington. ZAC was 82 per cent effective in the Colorado test, but only 29 per cent effective in Washington. The meadow mice involved were *Microtus montanus* in Colorado, and the much larger Townsend meadow mouse *(M. townsendii)* in Washington.

In Massachusetts, Dodge (1958) found that the highly active commensal rodent repellent, beta nitrostyrene, effectively repelled porcupines. This compound, in a polyvinyl latex adhesive, was 75-95 per cent effective in preventing porcupines from feeding on test materials and kept them from damaging outdoor structures. The other 18 repellents that we supplied for these studies—including TNB-A, ZAC, and TMTD—were not effective.

In experiments with beavers in New Mexico, Huey (1955) reported that a formulation containing 10 per cent TNB-A protected aspen groves for about 4 months. Tests with TNB-A, ZAC, and TMTD as beaver repellents are now in progress in Colorado. In 1 month, at one site, beavers have felled 35 of 150 untreated aspens, but only 4 of an equal number of treated trees.

In an initial trial of repellents for nutria in Louisiana, TMTD and ZAC afforded 65 per cent protection to corn plants but none to sugar cane. However, approximately three-fourths of the treated cornstalks damaged by nutria were cut above the 2-foot basal area that was treated.

REPELLENTS FOR LIVESTOCK

Duncan and Whitaker (1959) reported that repellents decreased cattle browsing of slash pine (*P. caribaea)* seedlings in central Louisiana. They found that TMTD reduced serious damage by 48 per cent, ZAC by 65 per cent, and TNB-A by 83 per cent; TNB-A, however, was harmful to seedlings. In a second study involving different methods of application, ZAC and TMTD reduced heavy damage by cattle by 56 and 47 per cent, respectively. Forty per cent of untreated seedlings were heavily damaged by cattle in the first study and 27 per cent in the second.

Other studies in southern Arkansas with loblolly pine seedlings confirmed the repellency of ZAC and TMTD to cattle. In addition, these treatments reduced browsing by goats by slightly more than 80 per cent at a planting where 74 per cent of untreated seedlings were damaged.

PRESENT STATUS OF REPELLENTS

The foregoing studies point out several new ways and possibilities of using chemical repellents to protect silvicultural and agricultural crops from mammal damage. One or more of these products should soon be available at many farm and garden supply stores throughout the United States. However, these repellents may often fail to give the results desired in preventing animal damage to many kinds of crops. Nevertheless, the use of repellents to solve wildlife damage problems is increasing, and wider use should lead to cheaper and more efficient products.

SUMMARY

Three chemical formulations have been developed into commercially available repellent products that are highly effective in protecting woody plants from damage by rabbits and hares, and which also are useful in protecting plants from damage by such mammals as deer, meadow mice, beavers, and livestock. The active ingredients of these formulations are trinitrobenzene-aniline, zinc dimethyl dithio carbamate cyclohexylamine complex, and tetramethyl thiuram disulfide. When formulated with certain latex or resin adhesives and suitable additives, they have protected plants for as long as 1 year in some field tests. One or more of these products should soon be available at many farm and garden supply stores throughout the country.

ACKNOWLEDGMENTS

The cooperation of personnel of federal and state wildlife and forest agencies and private forest organizations in conducting these studies is gratefully acknowledged. Numerous chemical companies also cooperated readily in supplying many chemicals free of charge. Special thanks are due Harry D. Hartwell and Nelson B. Kverno, Bureau of Sport Fisheries and Wildlife, Olympia, Washington, for a major part of the data obtained in repellent tests in the Pacific Northwest; to Dr. Van T. Harris, of the same agency, Lafayette, Louisiana, for conducting the nutria repellent tests; and to Mr. R. F. Kennedy, Crossett Company, Crossett, Arkansas, for conducting the deer and livestock repellent tests in Arkansas.

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DISCUSSION

DR. POPHAM: I think this is a wonderful piece of work that you are doing, Doctor, and we are for it. What we would like to see going right along with this sort of thing would be work on attractants for the pest that you are after. In other words, on the medfly program, by adding an attractant to the spray they could get better control with a half a pound of toxicant than you could with 2½ pounds without the attractant. So if we can find the attractant for the pest we are after, and can find the repellent for the wildlife in the area, and put the two together, we might have something pretty safe.

TECHNICAL SESSIONS

Monday Afternoon — March 2

Chairman: Robert D. Montgomery[1]
Regional Manager, California Department of Fish and Game, Sacramento, California

Discussion Leader: Howard L. Mendall
Leader, Cooperative Wildlife Research Unit, University of Maine, Orono, Maine

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WETLANDS AND INLAND WATER RESOURCES

THE CACKLING GOOSE—ITS MIGRATION AND MANAGEMENT

Urban C. Nelson and Henry A. Hansen[2]

U. S. Fish and Wildlife Service, Bureau of Sport Fisheries and Wildlife, Juneau, Alaska

Acknowledgments

To those biologists and Eskimos whose breathless, persistent pursuits in mud, mire and goose dung resulted in many successful banding operations, we express our appreciation. The activity reports of the Wildlife Refuge and Federal Aid programs in Alaska have been used freely. The basic literature and background field work have been documented in a companion project on the black brant (Hansen and Nelson, 1957). To the California Department of Fish and Game we acknowledge the information on California band returns, migration dates and harvest data. The Pacific Flyway Committee Reports have been used extensively for population data. The Bird Banding Office of the Patuxent Research Refuge has furnished all the band return information.

[1]In the absence of the Chairman, this meeting was presided over by Mr. Robert M. Paul, executive secretary, Sport Fishing Institute, Washington, D. C.
[2]In the absence of the authors this paper was read by Dr. John Buckley.

INTRODUCTION

The lack of positive field identification of the many subspecies of Canada geese, both on the breeding and wintering grounds where several races may occur together, has led to confusion in delimiting the range of the individual subspecies. The vernacular name "brant," as applied by many laymen to all races of small Canada-type geese as well as to the true brant, has created a void in the layman's contribution to distributional knowledge.

A long history of taxonomic lumping, splitting and change in nomenclature has frequently confounded even the technician. For instance, the new A.O.U. check list (1957) shows ten subspecies of *B. canadensis,* whereas Delacour (1951) recognizes 12 subspecies in his revision of the group. However, he lists *B. c. asiatica* from the western Aleutians as being extinct. Alaska is host to six of the subspecies, excluding *B. c. asiatica,* but including *B. c. taverneri,* which Delacour describes as a new subspecies although not yet recognized by the A.O.U. The extent of the breeding range of the numerous forms is no less contradictory itself. In fact, range and taxonomy are interdependent, each requiring a degree of accuracy in satisfying the other. Intergrading of races where ranges overlap further complicates the picture.

Although the taxonomy and ranges of the many subspecies of Canada geese have been and probably still are confusing, Delacour (1951) offers a logical basis for subspeciation, viz: "The last word on the taxonomy of Canada geese will be said only when all the breeding populations have been carefully studied. . . ." Nesting studies and associated banding now yield facts on which to describe the range and life history of the miniature form of Canada goose, *Branta canadensis minima,* correctly referred to as cackling goose. The 481 returns from 3,730 cacklers banded by Murie (1924), Spencer (1949), Elkins and Nelson (1950), Olson (1951), Adams (1952) and Hoffman (1954), summarized in Table 1, are basic to this study.

BREEDING RANGE

Detailed studies of Canada goose migrations during the past ten or fifteen years have shown a more limited migratory pattern than originally assumed (Hanson and Smith, 1950). Populations of Canada geese have been demonstrated to move as a "flock" from isolated breeding grounds to specific wintering grounds in a very direct and restrictive pattern. The cackling goose reflects this phenomenon to a marked degree.

Since the early exploration in Alaska the breeding range of the cackling goose has apparently shrunken considerably. The original nesting grounds extended from Agattu Island at the end of the Aleutians eastward along the coast and thence northward to the vicinity of Wainwright and possibly the Pribilof Islands, according to ornithological reports dating back at least to 1872. It is possible that a misidentification of what is now classified *B. c. minima* and *B. c. taverneri* may have been made, particularly in the northern part of this range. There are several early references along the Bering Sea coast and the Aleutians to *B. c. hutchinsi,* which is now relegated to a breeding area in the northeastern corner of the continent. Therefore, strict reliance in some of the early records may not be warranted. Based upon recent field studies we are inclined to agree with Delacour (1951) in distribution rather than the A.O.U. check list (1957).

There is good evidence that cacklers nested in abundance on some of the larger islands in the Aleutian chain but were decimated following the introduction of foxes. Murie (1937) identified a pair with a brood on Agattu and saw several others during a general reconnaissance of the Aleutians in 1936 and 1937. Preble and McAtee (1923) report the cackler as a regular migrant on the Pribilof Islands as late as 1919. Nelson (1883) recorded cacklers, at the time referred to as *Bernicla canadensis leucoparia,* to be resident in the Kotzebue Sound area, but McLenegan (1889) and Grinnell (1900) listed the resident Canada goose in this area as *B. c. hutchinsii.*

Since the initiation of the waterfowl program in Alaska in 1948 the cackling goose has been found to nest only along the coast between the Yukon and Kuskokwim Rivers. It has not been recorded from the interior even in migration. Where foxes were introduced in the Aleutian Islands most of the ground-nesting birds were destroyed. Near Selawik in the Kotzebue Sound area reindeer have been observed to destroy duck nests by trampling and by eating both eggs and nests. With a species as gregarious as cackling geese, almost colonial, isolated flocks nesting along the coast could quite readily have been destroyed by the introduction of reindeer. Thus, those early records which indicate a much more extensive breeding range than presently encountered could very well have been accurate in spite of the muddled taxonomy of the species.

MIGRATORY ROUTE

An analysis of band returns (Table 1) indicates a very restricted migration route for the cackling goose from its breeding ground on the Arctic tundra to its wintering area in California's interior valleys. It is interesting to note on the flight map (Figure 1) that the

TABLE 1. SUMMARY OF 3,581 CACKLING GEESE BANDED ON THE YUKON DELTA, ALASKA, SHOWING AREA OF RECOVERIES (PARENTHETICAL NUMBER IS PERCENTAGE OF BANDS RETURNED IN THAT YEAR)

	Number of bands recovered									
Area of Recovery	1949	1950	1951	1952	1953	1954	1955	1956	1957	Total
Alaska-Local[1]	4(10.8)	9(16.7)	2(4.9)	5(4.5)	7(10.7)	7(16.2)	3(10.4)	4(14.8)	1(6.7)	42(9.8)
Bristol Bay		3(5.6)		1(0.9)	2(3.1)		2(6.9)	1(3.6)		9(2.0)
Cold Bay					1(1.5)					1(0.2)
Kodiak Is.	1(2.7)									1(0.2)
B. C. Coast		3(5.6)		1(0.9)						4(1.0)
Pacific N.W.	5(13.5)	9(16.7)	1(2.4)	13(11.5)	5(7.6)	1(2.4)	2(6.9)			36(8.6)
Washington-Eastern							1(3.4)			1(0.2)
Oregon N.E.				6(5.4)		2(4.7)				8(1.9)
Klamath Basin	20(54.1)	11(20.2)	19(46.3)	54(47.8)	20(30.9)	18(41.7)	8(27.6)	6(22.2)	5(33.3)	161(37.6)
Sacramento Valley	7(18.9)	15(27.8)	14(34.4)	30(26.3)	18(27.7)	10(23.3)	9(31.0)	10(37.2)	6(40.0)	119(28.2)
San Joaquin Valley		4(7.4)	3(7.3)	3(2.7)	12(18.5)	5(11.7)	4(13.8)	6(22.2)	3(20.0)	40(9.5)
Nevada N.E.			1(2.4)							1(0.2)
Baja California			1(2.4)							1(0.2)
Total	37	54	41	113	65	43	29	27	15	424

[1]A local return is a bird taken within 100 miles of the banding site.

cackler changes its range completely from a very damp coastal tundra habitat in the summer and fall to a very dry, interior habitat in the winter. This change-over is geographically abrupt, taking place directly from the ocean through the Cascades.

Adult cacklers regain flight about August 10 and by August 15

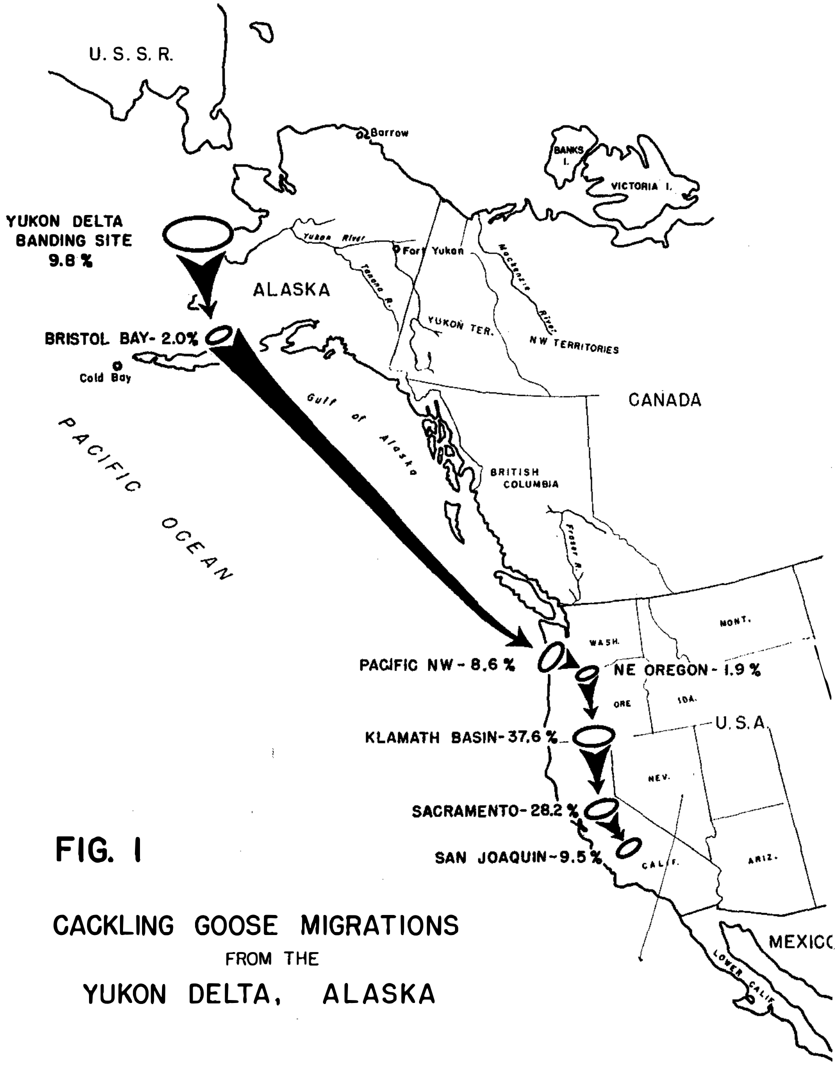

FIG. I

CACKLING GOOSE MIGRATIONS FROM THE YUKON DELTA, ALASKA the six-week-old goslings are testing their flight feathers. All are on the wing by August 25 when large flocks assemble. Eskimos report that the geese feed on tundra berries, *Empetrum* spp. along the coast prior to migration. From their breeding ground on the Yukon-Kuskokwim Delta, the cacklers move leisurely down the coast to the tundra of Bristol Bay at the base of the Alaska Peninsula. Some earlier reports, based on sight records, indicated that the cackler moved down the Peninsula joining the large goose-brant concentrations at Izembek Bay. Only one band, however, has been recovered from this area which receives considerable hunting pressure. Furthermore, only a very few cacklers have been checked and weighed in the Izembek-Cold Bay area. Most of the white-cheeked geese at Izembek are lesser Canada, *B. c. leucopareia* or *B. c. taverneri* or *B. c. parvipes,* depending upon whose nomenclature is acceptable.

From Bristol Bay in early October the cacklers cross the Alaska Peninsula near its base and thence the Pacific Ocean making landfall near the mouth of the Columbia River a few days later. The pattern of band recoveries indicates two definite flights, the first arriving south about October 15-20 and the second about October 25-30. They cross the Cascades and proceed rapidly along the eastern side of the mountains to the Klamath Basin and northeastern California where the majority of them linger until late November before proceeding to the Sacramento Valley. Most of the San Joaquin Valley band recoveries come from late in December until the end of the hunting season in January.

There appears to be but little deviation from this route. One band from Alaska-banded cacklers has been recovered from Kodiak Island in Alaska, one from Izembek Bay (Cold Bay), Alaska, four from the southern end of Vancouver Island, one from eastern Washington, one from northeastern Nevada and one from Baja California. Small flocks of cacklers are infrequently reported in the fall along the southeastern coastline of Alaska and occasionally one is shot from a flock of larger Canada geese. The authors have collected specimens in southeast Alaska in Icy Straits (1952), Farragut Bay (1953) and the Stikine River (1955). A few cacklers have also been checked in eastern and central Washington during the hunting season, but they are not common migrants inland until they reach Oregon.

Three hundred forty returns from 3,957 cackling geese banded by the California Department of Fish and Game in the Klamath Basin and Sacramento Valley between 1952 and 1957 substantiate the migratory path as delineated by Alaska-banded cacklers. In fact, there is even less deviation in the flight route described above from Alaska banding than by cacklers banded in the fall and winter in

California. One California band was recovered in the Northwest Territories of Canada and all the rest within the restricted flight route described. Perhaps the most significant fact revealed by these two complimentary banding programs is that there is only one population or "flock" of cackling geese with a single, restricted breeding ground. Any field work necessary for management of this species can be readily localized on either the breeding grounds or wintering grounds or at known stopping places along the migration route.

As yet there are no spring band recoveries to indicate the path nor timing of the northward migration to Alaska. However, based upon sight records, Gabrielson and Lincoln (1959) report a leisurely flight along the coast.

HARVEST AND MORTALITY

The band returns indicate a modest rate of harvest of cackling geese compared with other subspecies of Canada geese in the Pacific Flyway. The life tables (Tables 2, 3, 4 and 5) illustrating the pattern of mortality are based on the format described by Bellrose and Chase (1950). The survival series is also illustrated graphically in Figure 2.

As might be expected the vulnerability of geese is greater during their first hunting season than in subsequent years. In fact, juvenile geese are twice as vulnerable in the Pacific Northwest and the Klamath

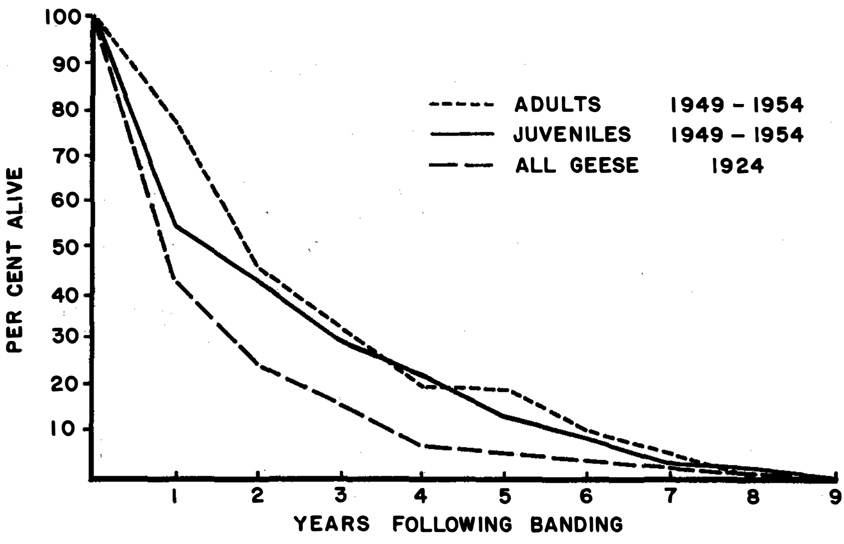

FIG. 2 COMPARATIVE SURVIVAL RATES OF CACKLING GEESE BANDED ON THE YUKON DELTA

TABLE 2. LIFE TABLE FOR 3,032 JUVENILE CACKLERS BANDED ON THE YUKON DELTA, ALASKA

Year of banding	Number Banded	Number of bands returned: Direct 1st yr.	2nd yr.	3rd yr.	4th yr.	5th yr.	6th yr.	7th yr.	8th yr.	9th yr.	Total No.	Total %
1949	673	38	11	10	9	6	3	3	1	1	82	12.2
1950	1,053	38	10	18	13	8	6	12	1		106	10.1
1951	443	18	7	10	1	5	3	1			45	10.2
1952	645	62	8	8	5	9	3				95	14.7
1954	218	9	5	1	1						16	7.3
Total	3,032	165 of 3,032 banded	41 of 3,032 banded	47 of 3,032 banded	29 of 3,032 banded	28 of 2,814 banded	15 of 2,814 banded	16 of 2,169 banded	2 of 1,726 banded	1 of 673 banded	344	11.3
% of bands recovered		5.44	1.35	1.55	0.96	0.99	0.53	0.74	0.12	0.14	11.82	
Mortality series		46.0	11.4	13.1	8.1	8.4	4.5	6.3	1.0	1.2	100.00	
Cumulative % of bands recovered		46.0	57.4	70.5	78.6	87.0	91.5	97.8	98.8	100.0		
Survival series		54.0	42.6	29.5	21.4	13.0	8.5	2.2	1.2	0.0		
Mortality rate		46.0	21.1	30.8	27.5	39.2	34.7	74.1	45.5	100.0		

TABLE 3. LIFE TABLE FOR 549 ADULT CACKLING GEESE BANDED ON THE YUKON DELTA, ALASKA

Year of banding	Number Banded	Number of bands returned: Direct 1st yr.	2nd yr.	3rd yr.	4th yr.	5th yr.	6th yr.	7th yr.	8th yr.	9th yr.	Total No.	Total %
1949	25				1	1					2	8.0
1950	37	3	2		1				1		7	18.9
1951	47	2		1	3						6	12.8
1952	440	15	26	11	5		8				65	14.8
Total	549	20 of 549 banded	28 of 549 banded	12 of 549 banded	10 of 549 banded	1 of 549 banded	8 of 549 banded		1 of 62 banded		80	14.6
% of bands recovered		3.64	5.10	2.19	1.82	0.18	1.46		1.61		16.00	
Mortality series		22.8	31.9	13.7	11.4	1.1	9.1		10.0		100.00	
Cumulative % of bands recovered		22.8	54.7	68.4	79.8	80.9	90.0		100.0			
Survival series		77.2	45.3	31.6	20.2	19.1	10.0		0.0			
Mortality rate		22.8	41.3	30.2	36.1	5.4	47.6		100.0			

TABLE 4. LIFE TABLE FOR 3,581 CACKLING GEESE BANDED ON THE YUKON DELTA, ALASKA

Year of banding	Number Banded	Number of bands returned: Direct 1st yr.	2nd yr.	3rd yr.	4th yr.	5th yr.	6th yr.	7th yr.	8th yr.	9th yr.	Total No.	Total %
1949	698	38	11	10	10	7	3	3	1	1	84	12.0
1950	1,090	41	12	18	14	8	6	12	2		113	10.4
1951	490	20	7	11	4	5	3	1			51	10.4
1952	1,085	77	34	19	10	9	11				160	14.7
1954	218	9	5	1	1						16	7.3
Total	3,581	218 of 3,581 banded	79 of 3,581 banded	64 of 3,581 banded	44 of 3,581 banded	30 of 3,363 banded	24 of 3,363 banded	17 of 2,278 banded	3 of 1,788 banded	2 of 698 banded	481	12.9
% of bands recovered		6.09	2.21	1.78	1.23	0.89	0.71	0.75	0.17	0.29	14.22	
Mortality series		42.9	15.6	12.6	8.8	6.4	4.9	5.4	1.3	2.1	100.00	
Cumulative % of bands recovered		42.9	58.5	71.1	79.9	86.3	91.2	96.6	97.9	100.0		
Survival series		57.1	41.5	28.9	20.1	13.7	8.8	3.4	2.1	0.0		
Mortality rate		42.9	36.4	30.4	30.4	31.8	35.8	61.4	50.0	100.0		

TABLE 5. LIFE TABLE FOR 149 CACKLING GEESE BANDED BY MURIE IN 1924 (ADULT PLUS LOCALS) ON THE YUKON DELTA, ALASKA

Number Banded	Direct 1st yr.	2nd yr.	3rd yr.	4th yr.	5th yr.	6th yr.	7th yr.	8th yr.	9th yr.	Total No.	Total %
149	33	10	5	5	1	1	1		1	57	48.3
% of bands recovered	22.2	6.7	3.3	3.3	0.7	0.7	0.7	0.0	0.7		38.3
Mortality series	57.9	17.6	8.8	8.8	1.7	1.7	1.7		1.7		100.0
Cumulative recovery	57.9	75.5	84.3	93.1	94.8	96.5	98.2		99.9		
Survival series	42.1	24.5	15.7	6.9	5.2	3.5	1.8		0.0		
Mortality rate	57.9	41.8	35.9	56.1	24.6	32.7	48.6				

Basin as geese are in their second year or older. Exclusive of Alaska and British Columbia, 154 bands were recovered from juveniles in their first year. Of those 154 bands 16.2 per cent were from the Pacific Northwest, 64.3 per cent from south central Oregon and northeastern California (Klamath Basin primarily), 14.9 per cent from the Sacramento Valley and San Francisco Bay area, and 4.5 per cent from the San Joaquin Valley. In contrast the returns from 219 cacklers recovered as two-year-olds or older are 9.1 per cent, 37.4 per cent, 38.3 per cent and 15.1 per cent from the above four areas, respectively. It appears that by the time cackling geese have started to arrive in the Sacramento Valley in mid-November most of the juvenile harvest has already taken place. Conversely over half the kill of adults occurs in the Sacramento and San Joaquin Valleys and the Bay area.

A significant contribution to the present study of the cackling goose accrues from the banding done on the Yukon Delta breeding grounds in 1924. Murie and Dufresne (1924) banded 149 cackling geese. A summary (Table 5) of the 57 recoveries from that banding shows the same migratory route as recent banding. However, the rate of return was more than two and one-half times as great as the return from cacklers banded in 1949-1954, 38.3 per cent compared with 14.2 per cent. There was also a shift in hunting pressures geographically, assuming that hunters have reported bands in the same relative proportions during the two periods. From the 1924 banding 5.5 per cent of the bands came from Alaska and 82.8 per cent from the Klamath Basin through San Joaquin Valley. From the 1949-1954 banding 12.2 per cent and 75.3 per cent came from the above two areas, respectively. There was no change from British Columbia and the Pacific Northwest. The comparative survival rates of cacklers banded under these diverse hunting pressures are illustrated in Figure 2.

A few questions of practical management application arise from these comparisons. Does the difference in rate of recovery of 14 per cent vs. 38 per cent reflect (1) shorter seasons and reduced bag limits (2) more efficient law enforcement or (3) the pattern of today's refuges and the cackler's adaptability to them? The question also arises that if the rate of harvest on cackling geese was more than three and one-half times as great in the late 1920's as now, what must have been happening to the more favored species such as Great Basin Canada geese, whitefronts, snow geese, etc. under the same conditions?

The difference in length and timing of the season does not seem to be a factor. The latest date a band from the 1924 banding was recovered and reported was on January 31 in 1927. Furthermore, no higher recovery rate from January hunting was reported then than now. No spring recoveries were reported outside of western Alaska.

POPULATION ESTIMATE

In the 500 square miles of optimum habitat between Igiak Bay and Nelson Island the breeding population of cacklers, as derived from the intensive 1951 aerial surveys, was about 30,000 geese. On the remaining 1,500 square miles used by nesting cacklers the aerial census showed an additional 10,000 geese. Calculated from a concurrent ground study by Olson (1951), the optimum 500 square miles supported about 60,000 cacklers based upon an average density of 62 nests per square mile. Subsequent air-ground comparison studies indicate that the number of waterfowl counted from the air is far less than the number actually resident on the ground. The breeding population, based upon Olson's ground census would have been about 80,000 cacklers. By including 60,000 non-breeders (based upon survival series in Table 2) and the summer production of 108,000 young as reflected in Olson's study, the fall population would approximate 250,000 geese.

When the harvest and winter inventory figures from recent years are added the total population is somewhat higher than this estimate. The average of the past five winter inventories has been about 172,000 cacklers. The average annual harvest of the past five years as reported from Oregon and California has been about 95,000. Band returns (Table 1) indicate that 80 per cent of the kill occurs there. The total harvest, then, would average about 118,000 annually plus an undetermined crippling loss. If the crippling loss, arbitrarily established at 10,000 geese, is added to the harvest and winter inventory figures, a total cackler population of 300,000 birds is derived.

In view of the gross delineation of the nesting area, the rough calculation of the breeding population, the vagaries of identifying various subspecies on the wintering ground and the difficulty of estimating total harvest reasonable allowances would place the cackling goose population between 250,000 and 300,000 birds.

MANAGEMENT NEEDS

From a harvest point of view, the cackling goose is in a healthy condition and it appears that this situation will continue as long as the current restrictive measures are necessary on the West Coast to protect other subspecies of Canada geese occupying the same habitat.

The status of the cackler could become quite vulnerable on the breeding grounds, however, largely because of inherent characteristics of the species itself. It is a highly gregarious bird, almost colonial in nesting and brooding habits. Its present breeding range is quite restricted along a narrow belt of low coastal tundra. It lays a relatively small clutch of eggs and consequently raises a small brood although nesting success has been quite high. Olson (1951) found cacklers in densities up to 146 nests per square mile averaging 4.02 eggs per nest and 3.7 young per brood. Hatching success under these conditions, based upon 124 completed nests, was 73 per cent.

One of the primary management needs is to assure protection of the breeding ground, all of which lies within the long proposed Yukon-Kuskokwim Game Management Area. Destruction or impaired efficiency of any part of this key habitat would immediately be reflected in a dwindling cackling goose population.

Indiscriminate oil development, large-scale reindeer activity, pollution or other man-induced factors could effect serious consequences on the breeding grounds.

Another primary management tool should be the restoration of ancestral breeding grounds on the Aleutian Islands. When fox farming became profitless, the Aleutian Island leasees abandoned their holdings and allowed the foxes to become feral. Under these conditions ground-nesting birds were doomed. If a seed stock of cacklers, and other waterfowl, have survived on unmolested islands, perhaps they can still come back on the larger, primary nesting islands once the foxes have been eradicated.

Obviously, present population estimates are inadequate for detailed management purposes. Creation of a National Wildlife Management area on the Yukon-Kuskokwim delta would serve a two-fold purpose: (1) opportunity to protect the breeding habitat from the decimating influences enumerated above and (2) give impetus to a continued study of all waterfowl populations in the area and factors influencing their production.

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DISCUSSION

MR. ALLEN DUVALL: I am with the Bureau of Sports Fisheries and Wildlife at Laurel, Maryland. If I undestood properly, John, there was a difference in recovery rates between the 1924 sample by Dufresne and Murie as opposed to more recent years. Did the authors attempt to draw any conclusions as to why it was much greater in 1924 than now? I presume that because we did not have the hunting regulations in 1924 that we do today, you could conceivably conclude that, because of the lack of enforcement, you would expect a larger kill when it was uncontrolled.

DR. BUCKLEY: The substance of this question regards the difference in the rate of return between the 1924 and 1949-1954 bandings.

The rate of return from banding was 38 per cent in 1924, and it is only 14 per cent now, about two and a half times less than in 1924.

I would expect that you are probably right, Mr. DuVal. There were marked differences in the regulations and the length of season at that time. On the other hand, there are some things in the data which lead one to think that maybe we are not harvesting as heavily as we might be. I can't comment much further on it.

MR. LARRY JAHN [Wisconsin]: What are the nesting habitat of the brants and the cacklers? From the pictures I would gather that they are meadow-type nesters and not island-type nesters. Is that correct?

DR. BUCKLEY: It is hard to define that area as meadow or as island. It is an extremely wet area of tidal sloughs and little potholes, and while they are not distributed uniformly over it, they do not nest on island situations primarily, as one finds in some other kinds of geese.

MR. JAHN: What was the density of nests per square mile?

DR. BUCKLEY: An average nest density of 62 per square mile, just a little short of one nest per 10 acres.

MR. WILLIAM LEITCH [Ducks Unlimited]: I wonder if you developed any particular driving techniques that might be of interest in that habitat.

DR. BUCKLEY: Again there are people in the audience better qualified to answer than I. I have never participated in the drives. However, the drives for the most part were aimed at capturing molting birds and young. It was a relatively simple process of surrounding an area and driving toward a small net, which was set up and used as a trap. There were no special methodologies involved. The only other requirements were webbed feet to get around in that country and a willingness to be completely wet all day in order to get across the sloughs. They always seem to be in the way.

MR. BODDY [Alaska]: I want to ask why the Izembek area is important enough to be set up as a wildlife management area at this time.

MR. BUCKLEY: This particular area, as we indicated, supports essentially all of the nesting population of cackling geese. In addition, it supports by far the majority of the nesting population of the black brant. Both of these are important species to the people on the West Coast. The brants in particular are harvested quite heavily in parts of California and Oregon. Figures for the cacklers show the same thing, so that actually this is a rather restricted area; and yet it produces by far the bulk of the black brant and the cackling geese.

There is only one other thing that I wish to comment on in regard to the rate of band return. These returns include the bands by hunting in the states, and they also include the spring kill by the native people in that area. There is no significant difference in the percentages of bands between the two periods of time, so that we can't attribute this to differences in take by the people of the Yukon-Kuskokwim Delta during the two periods.

LOUISIANA IMPOUNDMENTS: THEIR FISH POPULATIONS AND MANAGEMENT[1]

VICTOR W. LAMBOU

Louisiana Wild Life and Fisheries Commission, Baton Rouge

Because little was known about Louisiana impoundments, the present study was undertaken to gather basic data on impoundments and their fish populations. For the purpose of this report, only impoundments which have their watersheds in the upland timber type areas of Louisiana and are at least 500 acres in size are considered. All these impoundments have some type of man-made water control structure. Excluded from this report are all bodies of water located in the alluvial flood plain areas, prairie regions and the coastal marshes of the state.

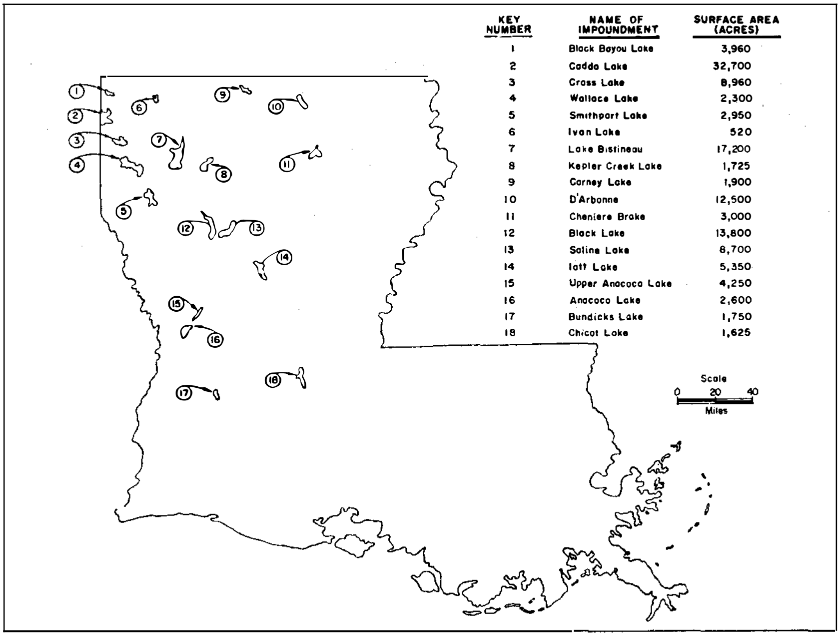
GENERAL DESCRIPTION OF LOUISIANA IMPOUNDMENTS

There are 18 impoundments[2] in Louisiana (Figure 1). The topography of the areas in which they are located varies from undulating and gently rolling to fairly hilly. The major forest types of these areas are the southern pines (longleaf, *Pinus palustris*; slash, *Pinus elliottii*; loblolly, *Pinus taeda*; and shortleaf, *Pinus echinata*) and upland hardwoods (post oak, *Quercus stellata*; blackjack oak, *Quer-*

[1]In the absence of the author, this paper was read by title.

[2]Three of the impoundments (D'Arbonne, Upper Anacoco, Bundick) are in various stages of construction or have been authorized by the Louisiana Legislature.

Figure 1. Louisiana, showing location of impoundments.



KEY NUMBER	NAME OF IMPOUNDMENT	SURFACE AREA (ACRES)
1	Black Bayou Lake	3,960
2	Caddo Lake	32,700
3	Cross Lake	8,960
4	Wallace Lake	2,300
5	Smithport Lake	2,950
6	Ivan Lake	520
7	Lake Bistineau	17,200
8	Kepler Creek Lake	1,725
9	Corney Lake	1,900
10	D'Arbonne	12,500
11	Cheniere Brake	3,000
12	Black Lake	13,800
13	Saline Lake	8,700
14	Iatt Lake	5,350
15	Upper Anacoco Lake	4,250
16	Anacoco Lake	2,600
17	Bundicks Lake	1,750
18	Chicot Lake	1,625

cus marilandica; southern red oak, *Quercus falcata;* white hickory, *Carya tomentosa;* sand hickory, *Carya pallida;* etc.). Much of the forests have been cut over and are in various stages of reforestation.

Bottom-land hardwoods (water oak, *Quercus nigra;* willow oak, *Quercus phellos;* overcup oak, *Quercus lyrata;* black willow, *Salix nigra;* tupelo gum, *Nyssa aquatica;* etc.) and baldcypress (*Taxodium distichum)* occur in the stream bottoms. It is mostly these bottoms which were dammed in constructing the impoundments.

Row-crop agriculture is not common in these areas. Grazing and timber production are the primary land uses. The soils of these areas are relatively low in fertility and are generally acid in nature.

The characteristics of the 18 impoundments can be summarized as follows:

	Total	Average	Range
Area (acres)[1]	125,790	6,988	520-32,700
Volume (acre feet)	813,345	45,186	3,360-175,000
Average depth (feet)		6.5	2.5-13.4
Drainage area (sq. miles)	9,513	529	46-2,740
Shoreline (miles)	690	38	12-131
Age (years)[2]		17	1-45

[1]Caddo Lake, the largest of the impoundments, is located partly in Texas and Louisiana. All other impoundments are located completely in Louisiana. Caddo Lake has an area of 32,700 acres of which 19,450 acres are located in Texas; therefore, the total area of impoundments in Louisiana is 106,340 acres.

[2]The three incomplete impoundments were not used in computing average age.

Impoundments, from which water quality data are available, were found to be slightly acid. Total alkalinity was usually less than 25 ppm. Normally the impoundments are very clear—except during periods of excessive rainfall. In Lake Bistineau, Lambou and Stern (1957) found that summer thermal stratification was incomplete and only temporary in nature. Moore (1952) found that Chicot Lake exhibited a period of thermal stratification during the summer of 1947; although during periods of heavy rains the thermal stratification was temporarily upset. However, Geagan and Fuss (1958) found no evidence of permanent summer thermal stratification in Chicot and Caddo Lakes during the summer of 1958. It would appear that in most of the impoundments, due to their shallowness, wind action usually will not allow a permanent stratification during the summer.

Because of the relative shallowness and clearness of the impoundments, submergent aquatics (coontail, *Ceratophyllum* spp.; blatterwort, *Uticularia* spp.; najas, *Najas* spp.; water milfoil, *Myriophyllum* spp.; waterweed, *Anacharis* spp.; fanwort, *Cabomba carolinana;* and various filamentous algae) are extremely abundant, in fact, so abundant they often seriously interfere with sport fishing. Water hyacinths *(Eichornia crassipes)* are present in most of the impoundments but for the most part are not abundant enough to seriously interfere with fishing. White water lily (*Nymphaea* spp.) and lotus (*Nelumbo lutea*) are locally abundant and troublesome in some of the impoundments.

Only Cross Lake was cleared prior to impoundment. Most of the trees which could not stand permanent flooding were killed and dead trees, logs and stumps are numerous in most of the impoundments. Also, scattered stands of live trees and shrubs which can tolerate permanent flooding (baldcypress; tupelo gum; button-bush, *Cephalanthus occidentalis;* etc.) are common. However, even these plants have been killed to some extent in the deeper areas of the impoundments.

In most of the impoundments, water levels are relatively stable. The two exceptions to this are Chicot Lake, which is fluctuated primarily to control submergent aquatic weeds, and Cross Lake, which fluctuates according to the water needs of the city of Shreveport.

PURPOSE, USE AND ADMINISTRATION OF THE IMPOUNDMENTS

The majority of the impoundments were built for recreational purposes, *i.e.,* fishing, hunting and boating. Only 4 of the 18 impoundments were constructed primarily for water supply, flood control and/or navigation; however, all the impoundments are used extensively for recreational purposes. In the aggregate the impoundments support a considerable amount of sport fishing; however, no data are available as to exact size of this fishery. The impoundments do not support the fishing pressure per unit of area as do some of the Louisiana bottom-land lakes which are located in more fertile soil types. However, most of the impoundments are located in areas where natural fishing waters are limited. It is expected that in the future impoundments will support a much larger portion of the fresh-water sport fishing in Louisiana than at the present. This is due to two reasons: an anticipated increase in the number of such impoundments and destruction of other types of fish habitat in Louisiana. Most of the impoundments support some commercial fishing; however, this fishery is not very large, especially when compared with the commercial fisheries on other types of waters in the state. Most of the impoundments are used to a greater or lesser extent for waterfowl hunting.

The majority of the impoundments are not managed by the Louisiana Wild Life and Fisheries Commission even though recreation (mainly fishing) was the primary purpose of building the impoundments. Local game and fish commissions have primary jurisdiction over seven of the impoundments, federal government agencies over three, parish governments over two, watershed and water conservation districts over two, Louisiana State Parks and Recreation Commission over one and a municipal government over one. The Louisiana Wild Life and Fisheries Commission has primary jurisdiction over two impoundments. Because these local game and fish commissions are peculiar to Louisiana, the nature of these agencies needs further clarification. The Lake Bistineau Game and Fish Commission, set up by an act of the Louisiana Legislature, is typical of these agencies. The commission is composed of three members, one elected by each of the three police juries of the three parishes bordering Lake Bistineau. The Commission has the power and authority to regulate and control the taking of game or fish; to establish closed seasons; to fix game and fish limits; to employ wardens, to fix fees for hunting and fishing on the lake; to buy, lease or sell property; to lease or let the privilege of commercial fishing; establish fish hatcheries; etc. However, all rules and regulations made by the Lake Bistineau Game and Fish Commission are subject to approval by the Louisiana Wild Life and Fisheries Commission. This control of the impoundments by many different agencies is not conducive to a consistent, sound, statewide fishery research and management program.

FISH POPULATION SAMPLING

Methods.—Fish populations in eight impoundments were sampled by rotenone poisoning. Practically all of the sampling areas were 1 acre in size. The impoundments sampled, dates of sampling and the number of sampling areas are as follows:

	Date Sampled	Number of Samples
Lake Bistineau	8-9/1955	18
Corney Lake	6/1955	3
Caddo Lake	7-9/1954	10
Chicot Lake	9/1954	2
Black Lake	7/1954	3
Black Bayou Lake	7/1954	5
Black Bayou Lake[1]	7-8/1956	5
Anacoco Lake	8/1955	3

[1]Black Bayou Lake was increased in size from 1,950 acres to 3,860 acres during the winter of 1954-55. Because of this, the data collected from Black Bayou Lake during 1954 and 1956 were treated as if collected from two different impoundments.

Since the impoundments were rather shallow (mostly less than 20 feet deep), it was possible to sample nearly all areas of the impoundments. The sampling areas were surrounded by a 1 inch square-mesh net, and for the most part, the "block-off net" described by Lambou and Stern (1958a) was used. Three pints of 5 percent emulsifiable rotenone per acre foot of water was applied by pumping the solution through a perforated hose. It was calculated that this would give a concentration of approximately 1 ppm. Fish were recovered over a 2 day period and every possible effort was made to pick up all, including small, fish.

Analysis of Data.—Recovery from each sampling area was converted to pounds of fish per acre so that each sample obtained from an impoundment would be given equal weight. Mean values for each impoundment were then determined. Each impoundment being considered separately, using the means for the eight impoundments for pounds of fish per acre, percent composition, etc., the general mean value for each index was determined. The fish recovered were separated into two main groups—non-predaceous and predaceous. Non-predaceous fish includes those types of fish that normally do not feed on smaller fish, while predaceous fish are those that usually feed on other fish and large forage animals. This grouping is similar to Swingle's (1950) forage and carnivorous or piscivorous grouping. Predaceous and non-predaceous species as here considered are shown in Table 1.

All species of fish that sportsmen normally fish for were grouped under the heading of game fish. Available game fish (harvestable-size game fish) are those that I considered to be of a size large enough to be creeled by sport fishermen. Since there is no size limit on game fish in Louisiana, any minimum size assigned to a species of fish is arbitrary. Game fish and their minimum available sizes are shown in Table 1.

TABLE 1. SPECIES OF FISH TAKEN FROM EIGHT LOUISIANA IMPOUNDMENTS WITH INFORMATION ON MINIMUM AVAILABLE SIZE. SPECIES CONSIDERED TO BE GAME FISH ARE MARKED BY AN ASTERISK (*) AND THOSE CONSIDERED TO BE COMMERCIAL FISH BY A DOUBLE ASTERISK (**).

Common name	Scientific name	Minimum available size (total length)
Non-predaceous fish		
*Bluegill sunfish	*Lepomis macrochirus*	5 inches
*Redear sunfish	*Lepomis microlophus*	5 inches
*Longear sunfish	*Lepomis megalotis*	5 inches
*Warmouth sunfish	*Chaenobryttus coronarius*	5 inches
*Spotted sunfish	*Lepomis punctatus*	5 inches
*Orangespotted sunfish	*Lepomis humilis*	5 inches
*Bantam sunfish	*Lepomis symmetricus*	5 inches
Pirate perch	*Aphedoderus sayanus*	....
Gizzard shad	*Dorosma cepedianum*	....
Threadfin shad	*Signalosa petenensis*	....
**Fresh-water drum	*Aplodinotus grunniens*	12 inches
**Buffalo fishes	*Ictiobus cyprinellus, I. niger* and *I. bubalus*	16 inches
**Suckers	Mostly *Erimyzon sucetta* and *Minytrema melanops*	None
**Yellow bullhead	*Ictalurus natalis*	None
**Black bullhead	*Ictalurus melas*	None
Madtoms	Mostly *Schilbeodes gyrinus*	....
American eel	*Anguilla rostrata*	....
Other fishes	Mostly minnows (Cyprinidae) and other small fishes	....
Predaceous fish		
*Largemouth bass	*Micropterus salmoides*	10 inches
*Spotted bass	*Micropterus punctulatus*	10 inches
*White crappie	*Pomoxis annularis*	7 inches
*Black crappie	*Pomoxis nigromaculatus*	7 inches
*Yellow bass	*Morone interrupta*	7 inches
*Chain pickerel	*Esox niger*	10 inches
**Longnose gar	*Lepisosteus osseus*	None
**Shortnose gar	*Lepisosteus platostomus*	None
**Spotted gar	*Lepisosteus productus*	None
**Alligator gar	*Lepisosteus spatula*	None
**Channel catfish	*Ictalurus punctatus*	14 inches
**Blue catfish	*Ictalurus furcatus*	14 inches
**Flathead catfish	*Pylodictis olivaris*	14 inches
**Bowfin	*Amia calva*	None

All species of fish that are regularly or occasionally sold commercially were grouped under the heading of commercial fish. Available commercial fish are those of a size that can be sold legally. If a species had no minimum size limit all sizes were considered as being available. Commercial fish and their minimum available sizes are shown in Table 1.

In analyzing the data, standard statistical methods such as those described by Snedecor (1946) were used. The population of fish in each lake sampled was considered as a sub-part of the fish population occurring in Louisiana impoundments. In all statistical calculations, the "Normal Theory" was applied.

Factors Affecting Accuracy of Results.—Data obtained from rotenone poisoning, or for that matter, data obtained from samples taken with any type of gear, are more or less selective. Rotenone sampling is probably less selective than other methods. The main inaccuracy associated with this method is that varying percentages of fish occurring in the sampling areas are recovered (Lambou and Stern, *op. cit.*). However, all samples were taken in a similar manner and it is believed that the ratio of non-recovered fish to recovered fish was of approximately the same magnitude for each sampling area. If this assumption is correct, the rotenone sampling data should furnish an unbiased index to the species composition, and the abundance of fish in the impoundments. The method of taking rotenone samples in Louisiana and the factors affecting the results are more fully discussed by Lambou and Stern *(ibid.)*

Standing Crops of Fish.—Standing crops of fish (pounds of fish per acre) occurring in the impoundments were low (Table 2)—on the average much lower than the standing crops of fish occurring in other types of habitat in Louisiana. An average of 73 pounds of fish per acre was recovered from the impoundments and the standing crops ranged from 13 for Corney Lake to 146 for Chicot Lake. Lambou (In Press) recovered, on the average, 397 pounds of fish per acre by rotenone poisoning from backwater lakes and Lambou and Stern (1958b) recovered, on the average, 202 pounds of fish per acre by rotenone poisoning from Mississippi River oxbow lakes in Louisiana. The differences in the standing crops occurring in the impoundments and the other types of habitat are significant at a probability of 0.05. These differences can be partly explained by the basic fertility of the soil types in which the various types of water are located. The impoundments are located in relatively infertile soil areas of Louisiana while the other types of lakes are located in the alluvial flood plain areas of Louisiana which are rich in the basic elements essential to the subsistence of plant and animal life.

An average of 59 pounds of non-predaceous fish per acre was recovered from the impoundments comprising 81 percent of the standing crops. The range was 10 to 111 pounds per acre comprising from 70 to 90 percent of standing crops in the various impoundments. Gizzard shad, bluegill sunfish, redear sunfish, warmouth sunfish, threadfin shad and suckers were the principal non-predaceous fishes occurring in the impoundments comprising, on the average, 29, 19, 10, 5, 5, and 4 percent of the standing crops respectively.

An average of 14 pounds of predaceous fish per acre was recovered from the impoundments comprising 20 percent of the standing crops. The range was 3 to 35 pounds per acre comprising from 10 to 30 percent of the standing crops in the various lakes. Largemouth bass and black crappie were the principal predaceous fishes occurring in the impoundments comprising, on the average, 10 and 3 percent of the standing crops respectively.

TABLE 2. STANDING CROPS OF FISH, AS DETERMINED BY USE OF ROTENONE, IN EIGHT LOUISIANA IMPOUNDMENTS. AVAILABLE FISHES ARE THOSE AS LARGE OR LARGER THAN THE MINIMUM ACCEPTED SIZES SHOWN IN TABLE 1.

Kind of fish	Pounds per acre			Percent of total standing crop (weight)		
	Mean for all lakes	Fiducial interval probability 0.05	Range	Mean for probability	Fiducial interval probability 0.05	Range
Non-predaceous fish	59.3	29.2- 89.4	9.6-110.5	80.5	74.2-86.8	70.4-89.6
Bluegill sunfish	13.7	5.3- 22.1	2.5- 33.0	19.2	11.6-26.8	8.0-34.6
Redear sunfish	6.0	2.5- 9.5	1.7- 11.9	9.9	4.7-15.1	2.8-19.6
Warmouth sunfish	3.7	1.0- 6.2	0.6- 9.7	5.3	1.4- 9.2	1.7-16.0
Spotted sunfish	0.4	0.1- 0.7	1- 1.1	.5	0.1- 0.9	*- 1.4
Gizzard shad	24.1	6.3- 41.9	0.0- 62.5	28.9	11.9-45.9	0.0-62.0
Threadfin shad	5.6	0.0- 18.6	0.0- 44.1	4.7	0.0-15.4	0.0-36.2
Suckers	1.4	0.5- 2.3	0.1- 3.1	4.3	0.0-11.0	0.2-23.8
Yellow bullhead	0.3	0.0- 0.6	0.0- 1.2	0.4	0.1- 0.7	0.0- 0.9
Other fishes	4.3	1.2- 7.4	*- 10.0	7.4	0.0-16.0	*-31.9
Predaceous fish	13.8	5.3- 22.3	3.4- 35.4	19.5	13.2-25.8	10.4-29.6
Largemouth bass	6.8	2.3- 11.3	1.7- 16.2	10.1	5.1-15.1	2.5-19.5
White crappie	0.7	0.0- 1.6	0.0- 3.0	0.8	0.1- 1.5	0.0- 2.0
Black crappie	2.7	0.0- 6.1	0.1- 11.7	3.3	0.4- 6.2	0.2- 8.6
Other fishes	3.7	0.5- 6.9	0.4- 11.8	5.4	1.5- 9.2	0.7-14.9
Total	73.1	36.6-109.6	13.0-145.8	....	....	....
Game fish	35.1	16.9- 53.3	9.9- 75.1	52.0	35.0-69.0	32.1-79.2
Available game fish	20.8	8.7- 32.9	6.5- 42.5	32.6	16.0-49.2	12.2-61.6
Commercial fish	7.5	2.8- 12.2	1.3- 18.3	13.5	4.6-22.4	2.1-29.4
Available commercial fish	7.0	2.3- 11.7	1.3- 18.2	12.1	4.7-19.5	2.1-23.8

*Less than 0.5.

An average of 35 pounds of game fish per acre was recovered from the impoundments ranging from 10 to 75 pounds per acre for the various impoundments. Game fish comprised an average of 52 percent of the standing crops, ranging from 32 to 79 percent for the various impoundments. An average of 8 pounds of commercial fish per acre was recovered from the impoundments, ranging from 1 to 18 pounds per acre. Commercial fish comprised an average of 14 percent of the standing crops, ranging from 2 to 29 percent. An average of 7 pounds of available commercial fish per acre was recovered from the lakes, ranging from 1 to 18 pounds per acre. Available commercial fish comprised an average of 12 percent of the standing crops, ranging from 2 to 24 percent.

Standing Crops of Available Game Fish.—On the average, 21 pounds of available game fish were recovered from the impoundments, ranging from 7 to 43 pounds per acre (Table 3). Available game fish made up 33 percent of the total standing crops of fish. Available-size bluegill sunfish, largemouth bass, redear sunfish, warmouth sunfish and black crappie were abundant with standing crops of 6, 5, 4, 2 and 2 pounds per acre respectively. These species made up approximately 11, 7, 7, 3, and 2 percent of the total standing crops respectively.

Approximately 56 percent of the total poundage of game fish consisted of available-size fish (Table 3). The percent of the total poundage of game fish of available size ranged from 34 to 78 percent. Approximately 48 percent of the total poundage of bluegill sunfish, 72 percent of redear sunfish, 51 percent of warmouth sunfish, 74 percent of largemouth bass and 67 percent of black crappie were of available size.

Predator-Prey Relationships.—An average of 5.0 pounds of nonpredaceous fish per pound of predaceous fish was recovered from the impoundments. The values ranged from 2.4 to 8.6 and the fiducial interval (probability of 0.05) was from 2.9 to 7.1. These values were higher than those obtained from other types of habitat in Louisiana (Lambou and Stern, *ibid.;* Lambou, *op. cit.*). The values obtained from the impoundments seem to be similar to the F/C ratio values (F equals the total weight of all forage fishes and C equals the total weight of all carnivorous fishes in the population) Swingle *(op. cit.)* obtained from ponds in Alabama. Swingle concluded that F/C values in the range of 3.0 to 6.0 were the most desirable in order to have proper balance in ponds. However, the ratio of the pounds of nonpredaceous fish per pound of predaceous fish does not show the weight of forage the predators can utilize for food. In order to determine this relationship, the following values must be determined: (1) the

TABLE 3. STANDING CROPS OF AVAILABLE FISH FOR THE PRINCIPAL GAME FISHES AS DETERMINED BY USE OF ROTENONE IN EIGHT LOUISIANA IMPOUNDMENTS WITH INFORMATION ON PERCENT OF TOTAL STANDING CROP OF THE VARIOUS GAME FISHES WHICH WERE OF AVAILABLE SIZE.

Kind of fish	Available game fish: Pounds per acre: Mean for all lakes	Fiducial interval probability 0.05	Range	Available game fish: Percent of total standing crop (weight): Mean for all lakes	Fiducial interval probability 0.05	Range	Percent of the total standing crops (weight) of the various game fishes which were of available size: Mean for all lakes	Fiducial interval probability 0.05	Range
Bluegill sunfish	6.4	1.8-11.0	0.7-14.6	10.6	3.0-18.1	1.0-23.7	48.2	26.3-70.1	7.9- 81.6
Redear sunfish	4.1	1.9- 6.3	1.5- 8.6	7.0	3.3-10.8	2.2-14.3	71.9	63.0-80.8	59.6- 94.1
Warmouth sunfish	2.1	0.0- 4.2	0.3- 7.6	3.1	0.0- 6.3	0.9-12.6	50.5	38.0-63.0	32.1- 79.1
Largemouth bass	5.1	1.9- 8.2	1.0-11.2	7.4	3.6-11.2	2.1-13.7	73.7	65.3-82.1	56.5- 86.1
Black crappie	2.1	0.0- 4.9	0.1- 9.3	2.4	0.0- 5.0	0.1- 8.0	66.7	42.5-90.9	10.0-100.0
Total game fish	20.8	8.7-32.9	6.5-42.5	32.6	16.0-49.2	12.2-61.6	56.4	42.8-70.0	34.2- 77.8
Predaceous game fish	8.0	2.0-14.1	1.7-22.5	11.6	5.4-17.8	2.3-22.3	72.4	63.9-80.9	56.4- 85.6
Total sunfish	12.8	5.7-19.9	4.2-27.6	21.0	9.4-32.6	6.0-45.5	52.9	58.6-67.2	28.0- 69.9
Total crappie	2.5	0.0- 5.8	0.2-11.3	3.0	0.1- 5.8	0.2- 8.8	68.8	45.5-92.1	17.4-100.0

total weight of predaceous fish of a size large enough to feed mainly on other fish or other forage animals (large crustaceans) and (2) the total weight of fish or other forage animals of a size small enough to be utilized for forage by the predators (Swingle, *ibid.;* Lambou, *op. cit.*). Sufficient information to allow the determination of exactly what size forage fish could be utilized by the predators in the population sampled was not available.

In order to make approximations of this predator-prey relationship, the following ratio was calculated: the pounds of all fish under 5 inches per pound of predaceous fish over 5 inches in the population. For a discussion of this approximation of the predator-prey relationship and factors affecting the determination of this relationship, see Lambou *(ibid.)*.

On the average there were 1.6 pounds of fish under 5 inches for each pound of predaceous fish over 5 inches in the impoundments. The range was 0.5 to 5.5 and the fiducial interval (probability of 0.05) was 0.2 to 2.9. These values were higher than those obtained from backwater lakes in Louisiana (Lambou, *ibid.*). An average of 0.2 of a pound of fish under 5 inches for each pound of predaceous fish over 5 inches was recovered from the backwater lakes. However, it was concluded that crayfish were important in the diet of the large predators in the backwater habitats (Lambou, *ibid.*). The values obtained from the impoundments appeared to be similar to the Y/C ratio values (Y equals the total weight of those fishes in the forage group that are small enough to be eaten by the average size adult in the carnivorous group of fish and C equals the total weight of the carnivorous fish) Swingle *(op. cit.)* obtained from ponds in Alabama. Swingle concluded that Y/C values in the ranges of 1.0 to 3.0 were the most desirable in order to have the proper balance in ponds.

MANAGEMENT OF IMPOUNDMENTS FOR SPORT FISHING

In the past, management procedures for the impoundments have consisted of the following: regulation of the sport fishing, regulation of the commercial fishing, stocking, building of fish ladders, spraying of water hyacinths with 2,4-D (2,4-dichlorophenoxyacetic acid) and fluctuation of water levels. As would be expected, due to the many different agencies having jurisdiction over the impoundments, management procedures have varied considerably from impoundment to impoundment.

At the present there are no special regulations on the impoundments pertaining to sport fishing—this has not always been the case. Louisiana has no size limits or closed seasons on game fish. Statewide daily creel limits are as follows: 50 sunfish, 25 crappie, 25 striped bass (white bass, *Roccus chrysops,* and/or yellow bass) and 15 black bass per day. It is doubtful if further liberalization of creel limits on the impoundments would have any appreciable effect on the sport fish harvest. For example, from the period May, 1955 through August, 1956, not 1 out of 923 bass fishing parties checked on Lake Bistineau and who had completed their fishing trip made a limit catch. During the same period, only 3 fishing parties out of 447 fishing for crappie and only 10 fishing parties out of 1,058 fishing for sunfish made limit catches.

In the past there have been many instances of closing impoundments to commercial fishing. At the present commercial fishing is not allowed on three impoundments. I know of no reason why commercial fishing should not be allowed on all the impoundments. Commercial fish are not very abundant in the impoundments and it is doubtful that either restricting or allowing commercial fishing will have much effect on the fish population. Nevertheless commercial fishing should be allowed since it utilizes a resource that would otherwise be wasted.

There has been considerable stocking of the impoundments with fingerling warm-water game fishes obtained from hatcheries and adult fishes seined from other waters. The principal fishes used in these stockings were largemouth bass, crappie, and sunfishes. At the present, one agency operates a hatchery in order to stock the impoundment under its jurisdiction. I doubt if this type of management had any measurable effect one way or the other on the fish populations in the impoundments (Lambou, 1955).

On Lakes Chicot and Bistineau fish ladders were constructed in order to pass fish which congregate below the dams into the impoundments. Schafer and Geagan (1958), in their study of the Chicot Lake fishway, have shown rather conclusively that no benefits occur from having such a structure.

One of the most successful attempts at management has been the water hyacinth control program of the Louisiana Wild Life and Fisheries Commission. Whenever water hyacinths become overabundant on any of the impoundments, they are sprayed with 2,4-D. Were it not for this program, the impoundments would become almost completely covered with water hyacinths which would eliminate their value for recreational purposes.

The water level of Chicot Lake has been fluctuated in order to control submergent aquatics. Chicot Lake is usually drawn down during early winter and refilled early the following spring and these drawdowns have materially reduced the abundance of aquatics in the lake. Management plans calling for a late summer or fall drawdown have been proposed for other impoundments; however, these plans have not been put into effect.

It appears that controlled drawdowns of water levels during late summer or fall offer the best possibility as a sport fishery management tool for the impoundments. The use of drawdowns as a fishery management tool has been discussed in detail by Wood, Roberts and Booth (1947), Wood (1951), Bennett (1954), Wood and Pfitzer (1958), Hulsey (1958), etc. It is believed that drawdowns will increase the fertility of the impoundments and improve the structure of the fish population as well as help to control overabundant aquatics. Drawdowns have also been recommended for the impoundments by game biologists in order to improve their attractiveness to waterfowl (Smith, 1959). It is recognized that considerably more research needs to be done on the use of drawdowns in the management of these impoundments. However, I feel that on the basis of what is presently known, drawdowns should be recommended for the impoundments. Hulsey (*op. cit.*), in his paper proposing a management plan for reservoirs in which drawdowns were of paramount importance, had this to say relative to the need of a positive program for the management of reservoirs: "Thousands of people each year are asking for advice and guidance, and if we, as the fishery experts, cannot give them definite, positive answers, we have failed in our job. Everyone understands that what might be the approved management recommendations in the year 1958 will possibly be obsolete in the year 1968. However, it is our duty as professional fishery workers to give our people a positive plan of action now—and not waver in a sea of indecision. Thousands of acres of new waters are being created each year, and if the fishery professionals do not come forth with concrete management plans for these waters, then the engineers, agriculturists and water commissioners will go ahead, construct and operate these new water areas according to their designs. As a consequence, the potential fisheries benefits of these new waters may not be realized." In this I completely concur.

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RANGE CONDITIONS, LIFE HISTORY, AND FOOD HABITS OF THE EVERGLADES DEER HERD[1]

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Everglades deer occupy a range encompassing approximately 2,000 square miles of seasonally flooded, fresh-water marsh, located in southeastern peninsula Florida. These deer, which are classified as Florida white-tailed deer (*Odocoileus virginianus seminolus* Goldman and Kellogg), are unique because they occur in an environment that is almost completely aquatic. They are nonmigratory and remain in this environment throughout the year.

Investigations have been confined principally to the 725,300-acre Everglades Wildlife Management Area that comprises the Central and Southern Florida Flood Control District's Conservation Areas 2 and 3 (Fig. 1). These Conservation Areas have been established for purposes of water and wildlife conservation and will eventually be encircled by a system of levees and water control structures.

Intensive studies were initiated in January 1956. The objective has been to acquire a knowledge of the ecology and life history of Everglades deer to serve as a basis for management.

Many individuals and organizations have contributed in one way or another to this study. We are particularly grateful, however, to the following personnel of the Florida Game and Fresh Water Fish Commission: E. B. Chamberlain, Jr., H. E. Wallace, W. T. Ware, Donald D. Strode, J. O. Brown, Thomas Shirley, Lewis Conrad and Anne Baldwin.

RANGE DESCRIPTION

The Everglades originally covered an area of approximately 3,100 square miles but about 1,100 square miles, located principally in the northern portion of the region south of Lake Okeechobee, have been drained for agricultural purposes. This vast marsh is an area of very low relief that rises from only 2 or 3 feet above mean sea level in the southern reaches of Everglades National Park to 18 feet near Lake Okeechobee at the northern limits. This gently sloping, flat physiognomy is interrupted by slightly elevated sites, possessing growths of low trees, called bayheads or tree islands. Surface water is usually present over the entire marsh for the greater portion of

[1]A contribution of Federal Aid in Wildlife Restoration Act, Project W-39-R, Wildlife Investigation of Central and Southern Florida Flood Control Project.

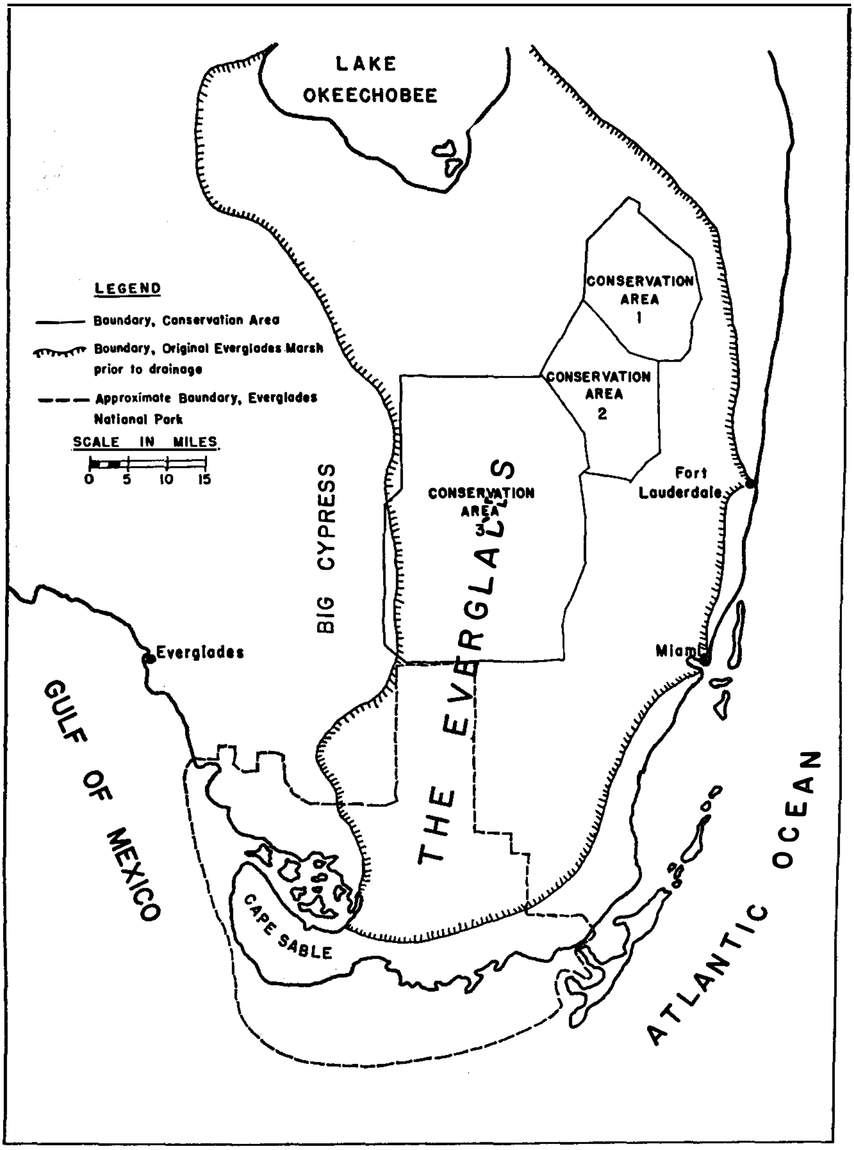
LAKE
OKEECHOBEE
LEGEND
Boundary, Conservation Area
Boundary, Original Everglades Marsh prior to drainage
Approximate Boundary, Everglades National Park
SCALE IN MILES
0 5 10 15
CONSERVATION AREA 1
CONSERVATION AREA 2
CONSERVATION AREA 3
BIG CYPRESS
THE EVERGLADES
Fort Lauderdale
Miami
Everglades
GULF OF MEXICO
CAPE SABLE
ATLANTIC OCEAN

Figure 1.

most years. During drought periods, however, the area is almost completely dry and at such times is often swept by fire. A mantle of organic peat or muck covers much of the region. These surface deposits are underlain with calcareous limestone strata of recent marine origin.

The most characteristic climatic feature of the Everglades is the marked seasonal variation in rainfall. For example, mean annual precipitation is about 65 inches but 75 percent of this total usually occurs from May through October (U.S.D.A., 1941). The distinctly seasonal rainfall condition contrasts with very slight seasonal temperature variations that range from an average of 66°F. in January to 79°F. in July (U.S.D.A., op. cit.). The region cannot be considered truly tropical, however, as killing frosts occur on an average of about once in five years (Davis, 1943).

The semitropical climate of the Everglades is characterized by slight seasonal changes in temperature, high humidity, and alternately wet summer-fall periods and dry winter-spring conditions, and is a significant consideration in any ecological evaluation of the area.

Hydrology:

The fauna and flora of the Everglades are notably influenced by hydrologic cycles. In turn, water conditions are dependent on localized as well as extensive principal drainage features. The generally flat relief and low elevation are accompanied by very slight changes in topographic configuration which decidedly affect drainage patterns and surface waters. There are few areas in the United States where the low and nearly flat topography is so extensive (Davis, 1943). These major, interrelated natural features, viz. drainage conditions and surface waters, determine, both directly and indirectly, the types and extent of the vegetation and wildlife in the Everglades. Because of the unusual importance of hydrologic influences considerable emphasis has been placed on an evaluation of these factors during this study.

Vegetation:

The principal vegetation components of the Everglades are the sawgrass, wet prairie, slough-aquatic and tree island communities (Loveless, 1959). These plant associations are comprised for the most part of temperate zone species, but tropical plants are frequently encountered, particularly in the tree islands. A brief description of the major communities that make up the range follows.

Sawgrass Communities—These communities are characterized by the large sedge, sawgrass *(Mariscus jamaicensis)*,[2] and constitute

[2]Source of scientific plant names, unless otherwise indicated, is Small (1931 and 1933).

approximately 65 to 70 percent of the total vegetative cover in the Everglades. In many sections of the range sawgrass occurs in almost pure, dense stands and the individual plants sometimes exceed ten feet in height. Among the more important herbaceous species that grow in association with sawgrass are flag *(Sagittaria lancifolia)*, maidencane *(Panicum hemitomon)* and pickerel weed *(Pontederia lanceolata)*. The drier, more elevated areas of the sawgrass associations support such trees as willow *(Salix amphibia)*, wax myrtle *(Myrica cerifera* L.*)* and dahoon holly *(Ilex cassine)*. These woody plants, particularly wax myrtle and willow, occasionally form very dense thickets.

Deer utilize these communities primarily for escape cover as the dense, rank growths of sawgrass and practically impenetrable shrub thickets provide them amply in this regard.

Wet Prairie Communities—These wet site communities are composed of species of relatively low stature plants such as beakrush *(Rhynchospora tracyi)*, spikerushes *(Eleocharis cellulosa* and *E. elongata)*, and such grasses as maidencane and *Panicum paludavagum*. Species common in the wet prairies that are important deer food plants are white water-lily *(Nymphaea odorata* Ait.*)* and swamp-lily *(Crinum americanum)*.

Tree Island Communities—Tree islands consist of growths of woody vegetation which occur on sites that are slightly higher than the surrounding marsh. They are dispersed generally throughout the entire region and range in size from only a few square feet to 300 acres or more. These islands may be ovoid to circular or strand-like in general outline and are elevated a few inches to three or four feet above adjacent areas. Their plant species components are definitive and they possess a physiognomic structure that is quite distinct. The ecotone between the tree islands and other communities is normally very abrupt and in many instances is only a few feet in width.

The dominant plants in the island communities are wax myrtle, dahoon holly, willow, red bay *(Tamala Borbonia)* and elderberry *(Sambucus Simpsonii)*. The ground cover is composed principally of ferns that in many cases form a luxuriant, dense growth and include such species as royal fern *(Osmunda regalis)*, marsh fern *(Dryopteris Thelepteris)* and swamp fern *(Blechnum serrulatum)*.

The higher elevated sites of many tree islands usually support large strangler fig trees *(Ficus aurea)*. Other species commonly present include southern hackberry *(Celtis mississippiensis)*, castor bean *(Ricinus communis)*, cabbage palmetto *(Sabal Palmetto)* and wild-coffee *(Psychotria nervosa)*. The ground cover in these areas is usually composed of admixtures of blood-berry *(Rivina humilis)*, *Dicliptera assurgens* L., false-nettle *(Boehmeria cylindrica),* and pokeweed *(Phytolacca americana).*

Many species of vines, such as *Melothria pendula,* greenbrier (*Smilax* spp.), *Aster carolinianus, Calonyction aculeatum* and *Muscadinea Munsoniana* are also present in the tree island communities.

Tree islands are the key to an understanding of the ecology of Everglades deer. Without these elevated sites that provide refuge and forage during unusually high water levels, it is unlikely that deer could exist for any extended period of time in this environment. Also, the island areas provide most of the available fawning sites in the range during high water periods and, regardless of prevailing water conditions, deer utilize them for escape and resting cover and as foraging areas throughout the year.

Slough-Aquatic Communities—Sloughs are the narrow, natural drainage channels that are usually water-filled most of the year. They are easily recognized by their drainage patterns and by the characteristic plant species present in them. White water-lily and floating heart *(Nymphoides aquaticum)* are the most conspicuous plants. Species such as spatterdock (*Nuphar advena* R. Br.), *Hydrotrida caroliniana,* and the bladderworts (*Utricularia* spp.) are also common. The slough communities are important to deer because of the abundance of food plants they provide.

Alligator Holes:

Alligator holes are open water areas that range from approximately 50 square feet to one-quarter acre in size. Their basins normally extend down to the rock stratum and they retain water throughout the year, even during extensive droughts. These natural water retention units are found throughout the range and are primarily the result of solution and the burning out of deep peat accumulations. Alligators often enlarge these holes and maintain them as open water areas, thus the derivation of the name.

Alligator holes are of considerable ecological significance to deer as they provide apparently essential water during drought periods (Loveless, 1959).

Fire:

Fire has had a significant influence on the composition of many plant communities in the Everglades. It is plausible to assume that during preaboriginal times fires were started by lightning strikes, and with the advent of the Indians and then white settlement wild fires became more frequent. As a consequence of long exposure to burning, associations of plants have resulted that are relatively fire tolerant. Fire, then, has a marked influence on the deer herd because of its effect on the vegetation. This influence is generally beneficial. For example, burning of the tree island communities creates conditions that encourage the establishment of important deer food plants such as elderberry, willow and groundsel bush *(Baccharis glomeruliflora)* and checks plant succession toward the less desirable associations.

Although some mortality undoubtedly occurs as a direct result of fire, no instance of this has been observed during the study. This period includes the extreme drought conditions of 1956 when some of the major fires in the history of the region occurred. An aerial survey after these series of fires revealed that approximately 60 percent of the management area burned during the unprecedented dry summer months of that year. Fire in the Everglades is therefore considered to be beneficial to deer, and within the scope of our knowledge and experience has not been a serious decimating factor.

HEALTH AND PHYSICAL CONDITION

General health and physical condition of Everglades deer usually decline with the advent of high water in the fall and improve as depths recede during the dry winter months and are directly related to the abundance, availability, and nutritive value of the forage. As water levels in the marsh increase and approach depths exceeding two feet, most of the herd becomes concentrated on the elevated tree island sites. They remain primarily in these crowded yarding areas until depths decline below this level at which time they move back into the marsh and respond to the abundance of natural food. By the time fawns are dropped in March the herd is usually in good physical condition. If water levels persist, however, above the approximate two-foot depth toleration point through the winter months, range conditions become critical as these limited areas are overbrowsed. Early evidence of critical range conditions is indicated by browse sign on such nonpreferred food plants as swamp milkweed *(Asclepias incarnata)*, strangler fig, leather fern *(Acrostichum daneaefolium)*, sawgrass and flag.

Some mortality does occur, particularly among yearlings and does, as a result of starvation and apparent pneumonia induced by malnutrition during extended high water periods. Deer occasionally succumb before extreme emaciation results and death, in many cases, cannot be attributed entirely to starvation. Several of these animals have shown signs of lung hemorrhages and it is suspected that unusually low temperatures (32°F. to 40°F.) accompanied by chilling winds, such as prevailed during the winter high water stages of 1957, contribute to the incidence of apparent pneumonia. Similar conditions of mortality resulting from pneumonia induced by excessive chilling and malnutrition have been reported by Cheatum (1951) in New York and Gerstell (1938) in Pennsylvania.

As mentioned earlier, mortality that occurs as a consequence of extended high water conditions favors the adult segment of the population, particularly the males. Die-offs from malnutrition involving differential mortality favoring adults have been reported for mule deer by Longhurst, *et al.* (1952) in California and by Robinette, *et al.* (1957) in Utah. Yearlings and adult does are more susceptible to adverse range conditions than mature bucks; it seems as water levels become appreciably high the does move with their young to the tree island sites and remain there, even to the point of starvation, until depths are more conducive to their return to the food supply of the open marsh. If high water persists through the winter months the does have the added demands of pregnancy which undoubtedly contribute to differential mortality. Mature bucks seemingly are not as confined by high water to the tree island sites since they are frequently observed feeding in the marsh during these periods in depths up to about 30 inches.

Parasitism and epidemic disease have not posed a serious threat to the herd but during critical high water stages, when deer become crowded on the limited tree island sites and suffer a subsequent decline in general physical condition, the possibility of excessive mortality due to these causes is evident.

LIFE HISTORY

Life history information was obtained from herd composition counts taken periodically throughout the year over prescribed routes of travel that covered most of the range with the exception of Everglades National Park. During the investigation 1,218 deer were classified as to sex or age or both. Life history data were required in order to establish such seasonal changes as antler development and to better evaluate the influence of high water on herd productivity.

Breeding and fawning dates are based on sight observations, and also on tooth development determinations of 24 fawns employing criteria described by Severinghaus (1949). Antler development and sex ratio information were obtained from composition counts and other correlative data.

Breeding Season and Fawn Drop:

Breeding activity in Everglades deer occurs throughout the year but is most pronounced during September. Rutting increases sharply in August, peaks in September, and subsides noticeably by late October. This August-October period corresponds with the usual cyclic peak in water depths over the range but the influence of high water on breeding activity is apparently of little consequence.

As previously indicated, fawns are dropped throughout the year. Data show, however, that a definite peak does occur with approximately 40 percent of the young born in March and 22 percent in April. During this early spring fawning period the range is usually dry, abundant forage is available, and fawning sites are more than adequate. In contrast is the condition that exists during unusually wet years when high water conditions prevail through the normally dry spring months and limit suitable forage and fawning areas to the tree islands. A considerable reduction in fawn survival occurs due to these adverse range conditions. For example, during the dry spring period of 1956, when excellent range conditions prevailed, herd composition counts showed the adult doe-fawn ratio to be 1.0:1.74. However, during the two unusually wet years of 1957 and 1958 the ratios were 1.0:0.66 and 1.0:0.71 respectively.

Antlers:

Bucks begin to shed their antlers in late November and complete the process by the end of January. Antler development commences about mid-February and is completed by mid-July. By late August bucks have rubbed off the velvet and possess clean, polished antlers. This is the normal cycle but it is not unusual to observe aberrations in the time sequence.

Adult Sex Ratios:

Information obtained from herd composition counts shows a mean spring and fall sex ratio for 1956 and 1957 of 33 percent bucks to 67 percent does, or 1 buck for every 2.17 does. This is not considered a deranged ratio and is, in fact, a rather healthy situation in a deer herd where only buck hunting is permitted. The average prehunting season ratio was 1.0:2.06 which compares with 1 buck for every 2.96 does in the Ocala herd (Strode, 1954) located in north-central Florida, and a 14 year average of 1.0:2.38 reported for deer in Wisconsin (Dahlberg and Guettinger, 1956).

POPULATION DYNAMICS

"One of the most vexing aspects of studying deer is trying to determine for any given period how many animals are being studied" (Leopold, A. S. *et al.*, 1951, page 113). In the Everglades studies both the aerial and the Lauckhart (1950) census techniques were employed in the approach to this problem. Although no allusion is made to precise accuracy we believe results suggest adequacy for management purposes.

Aerial Census:

Bowman (1955) has pointed out that the aerial survey is superior to most types of ground census methods because it enables a few observers to cover large, isolated areas. Trippensee (1948), Crissey (1948) and Edwards (1954) have suggested, however, its applicability is limited because of certain uncontrolled variables which restrict accurate results. In the aquatic, marsh-type habitat of the Everglades methods such as track or pellet group counts or other types of ground survey methods are unsatisfactory. Therefore, aerial census was one of the few techniques that suggested promise.

Flights were begun in the spring of 1956 when the area was completely dry and the herd was well dispersed. Also, fire had markedly reduced the vegetative cover and ground visibility was facilitated. A 136,000-acre representative unit was censused and a 7.5 percent coverage was attained by flying a series of parallel transect lines in a 135-h.p. Supercub PA 18 aircraft. Air speed averaged 80 to 100 miles per hour at an altitude of about 200 feet. Flights commenced roughly one-half hour after sunrise on clear, sunny days.

The herd in the 136,000-acre experimental unit was calculated to include about 1,000 to 1,200 deer in the spring and summer of 1956. This suggested a population for the management area of about 7,000 animals, or approximately 14,000 for the entire 2,000-square mile range.

Population Based on Buck Kill:

Lauckhart (1950) has suggested a method for estimating deer populations from herd composition figures and kill records, and presents curves from which can be read the approximate number of deer left on the range, after the hunting season, for every buck killed if herd composition is known. Number of deer on the Everglades range after the 1957-58 open season was calculated from Lauckhart's curves as shown in Table 1. This method indicates a deer population on the management area after the 1957-58 season of 7,800 animals which compares with the 7,000 preseason figure estimated from aerial census in 1956 and suggests that the aerial counts were undoubtedly conservative.

All factors included, the aerial survey and Lauckhart methods are considered to be basically adequate for management purposes in the Everglades. Aerial census was applicable, however, only during dry periods.

Productivity

Criteria employed in the estimate of productivity for Everglades

TABLE 1. POST-HUNTING SEASON (1958) DEER POPULATION, EVERGLADES WILDLIFE MANAGEMENT AREA, COMPUTED FROM LAUCKHART CENSUS METHOD.

Data	Herd Composition		
	Males	Females	Fawns (Average Survival)
Herd composition, fall 1957	32	100	70
Buck kill, 1957-58		600	
Number deer left on range per buck killed (Lauckhart, 1950)		13	
Post-hunting season population		7,800	

deer are those suggested by Leopold, A. S. *et al.* (1951). The basic premise involved in the computation hinges on the assumption that if a herd begins the winter period with a specified number of deer and ends the following year with approximately the same general population, productivity is comparable to total losses sustained.

Certain omissions in collected data are recognized, on a year to year basis, and thus in computing productivity it was necessary to utilize information for the periods it was available. Therefore, calculations presented in Fig. 2 are reflections of average productivity rather than for a specific twelve-month period.

Figure 2. Average annual productivity of Everglades deer.

Average winter population	7,500
Hunting mortality including crippling losses	700
Illegal kill	100
Losses due to starvation, disease, predation, etc. (20%)	1,500
Population minus losses	5,200
Number adult does in fall population (67%)	3,480
Number fawns born per adult doe (1:1)	3,480
Fawns reaching maturity in fall (70%)	2,435
Total population following year	7,635

From Fig. 2 it is noted that the average winter population of 7,500 cross checks satisfactorily with the 7,635 theoretical estimate. These data suggest an approximate average annual loss of 2,300 animals or a population preceding fawn drop of about 5,200 deer. Production then, expressed as a ratio of the winter population, is 31 percent.

Factors Influencing Productivity

Assuredly, there are many ecological intricacies that determine deer numbers on the Everglades range. Some of these factors have unquestionably escaped the attention of this study. Within the scope of collected data, however, it is possible to discuss those relationships which appear to have the greatest influence on population trends.

Evidential data show that annual average mortality losses from all causes are about 30 percent. These include an approximate 10 percent hunting mortality (including crippling losses and illegal kill) and a 20 percent loss of the remainder due to what may be considered "natural" mortality. It has been concluded that annual productivity approximates this annual loss and thus, over a period of years, population density is maintained at fairly consistent levels. Variations in this adjusting mechanism are recognized. For example, during critical range condition periods losses from starvation alone may equal or exceed 30 percent of total herd numbers, and fawn survival may be subsequently low. During favorable years, however, natural losses may not exceed 15 percent and reproduction may be unusually successful. Thus, heavy losses sustained during one year are seemingly compensated for by increased reproductive success and survival following periods of high mortality. Population removal acting to stimulate successful reproduction has been demonstrated in various animal populations by Errington (1945), Leopold, A. *et al.* (1943), Leopold, A. S. *et al.* (1951) and others.

Leopold, A. S. (op. cit.) has aptly remarked "there is inherent in a deer population a reproductive capacity which more than compensates for all ordinary losses and still produces a substantial surplus. The one effective factor which precludes continuing increase is lack of adequate, high protein winter food" (page 123). On the Everglades range periodic starvation losses that result from high water conditions, leading to herd concentration on elevated sites and subsequent depletion of nutritious forage, is the adjusting factor which holds population numbers at present mean levels. Preliminary browse studies and nutritive analyses of key forage species suggest a range capacity that exceeds present indicated herd densities, providing the severity of periodic die-offs occasioned by high water levels could be reduced.

In summary, it appears the Everglades deer herd is a rather stable population as herd losses are compensated for by reproductive effort, and density is generally regulated by prevailing range conditions. Population numbers vary from year to year depending largely on the amount of seasonal rainfall and resulting water levels which determine the amount of available nutritions forage and survival of young to maturity.

FOOD HABITS

Food habits data were obtained from the analysis of 22 rumen samples collected during the fall and winter months and from browse segregating identifiable material and then estimating volume by the studies conducted in the summer. Rumen samples were analyzed by water displacement method. Browse studies were restricted to the tree islands as they were inapplicable in the aquatic communities. Methods employed were similar to those described by Harlow (1955) in that random plots were taken on predetermined transect lines and utilization of plants by deer was estimated to the nearest 5 percent. Quantitative data are presented in Tables 2 and 3.

TABLE 2. FOOD HABITS BASED ON 22 RUMEN SAMPLES (OCTOBER-JANUARY).

Species[1]	% Volume	% Freq. Occur.	Parts Eaten
Nymphaea odorata Ait.	30	68	Leaves, stems and rootstocks
Osmunda regalis	28	77	Leaves and stems
Salix amphibia	11	82	Leaves and twigs
Crinum americanum	11	68	Leaves and rootstock
Smilax laurifolia	4	27	Leaves and fruit
Jussiaea peruviana	4	36	Leaves and twigs
Baccharis glomeruliflora	3	36	Leaves, twigs and fruit
Unidentified material	3	....	....
Smilax auriculata	2	4	Leaves
Utricularia sp.	2	45	Stems
Proserpinaca palustris	1	9	Leaves, stems and fruit
Psidium Guajava	1	4	Leaves and fruit
Ludwigia alata	T	45	Leaves and stems
Panicum spp.	T	32	Leaves
Sambucus Simpsonii	T	32	Leaves and stems
Hymenocallis tridentata	T	14	Leaves
Gerardia purpurea L.	T	14	Leaves and stems
Myrica cerifera L.	T	9	Leaves and twigs

[1]Fourteen plant species that did not exceed 0.5 percent by volume or 4 percent in frequency of occurrence follow: *Ludwigia natans, Rhynchospora* sp., *Melotheria pendula, Ipomea sagittata, Glycine Apios, Vigna repens, Eleocharis elongata, Gyrotheca tinctoria, Oxypolis filiformis, Rivina humilis, Aster carolinianus, Bidens leucantha* L., *Anchistea virginica* and *Polyporus hydnoides* Swartz ex Fries.

TABLE 3. UTILIZATION OF PLANT SPECIES IN THE TREE ISLAND COMMUNITIES BASED ON BROWSE STUDIES (JUNE-JULY).[1]

Plant Species	Percent Utilization	Occurrence
Sambucus Simpsonii	33	Common
Rivina humilis	21	Common
Dicliptera assurgens L.	20	Common
Baccharis glomeruliflora	12	Common
Boehmeria cylindrica	8	Infrequent
Smilax spp.	6	Infrequent
Citrus aurantium	4	Rare
Glycine Apios	4	Rare
Solanum gracile L.	1	Rare
Ampelopsis arborea	1	Rare
Aster carolinianus	1	Rare

[1]Medium to heavy browse sign was observed on the following species in or immediately adjacent to elevated sites during high water conditions: *Phytolacca americana, Ficus aurea, Asclepias incarnata, Emilista tora, Sagittaria lancifolia, Acrostichum danaefolium, Mariscus jamaicensis, Ditremexa ligustrina, Calonyction aculeatum, Litobrochia tripartita, Ilex cassine* and *Cicuta Curtissii.*

Fifty-one species of plants have been identified that are eaten by deer in the Everglades. Included are 11 species of tree-shrubs, 16 hydrophytic forbs, nine mesophytic forbs, nine vines, four ferns, one grass and one saprophyte. Ten of these plants comprise the bulk of the diet. They are *Nymphaea odorata* Ait., *Crinum americanum, Salix amphibia, Smilax* spp., *Jussiaea peruviana, Sambucus Simpsonii, Rivina humilis, Dicliptera assurgens* L., *Baccharis glomeruliflora* and *Osmunda regalis*. All of these are either non-deciduous trees or herbaceous perennials. *Nymphaea* and *Crinum* occur in aquatic communities and the remainder on tree islands. Thus, deer on the Everglades range eat a wide variety of plants but depend on relatively few species for their primary sustenance.

SUMMARY

Results are reported from an investigation of Everglades deer. Studies were confined primarily to the 725,300-acre Everglades Wildlife Management Area and were initiated to acquire a knowledge of the ecology of Everglades deer to serve as a basis for management. Intensive field work began in January 1956.

Everglades deer occupy a range encompassing about 2,000 square miles of seasonally flooded fresh-water marsh in southeastern Florida. Principal vegetational components are the sawgrass, wet prairie, slough-aquatic and tree island communities.

Surface water covers the range the greater portion of most years but during drought periods the area is dry and often swept by fire. Fire is generally beneficial, however, as it creates conditions that encourage the establishment of many important deer food plants and checks plant succession toward the less desirable associations.

During unusually wet years water depths may exceed three feet over an extensive region. When these high water levels persist through the winter and spring months range conditions become critical as the deer concentrate on elevated sites and rapidly deplete available nutritious forage. Mortality due to starvation and disease induced by malnutrition are serious decimating factors during these periods. Thus, periodic critical range conditions with attendant mortality is the adjusting mechanism that prevents any appreciable increase in mean population numbers.

Fall adult sex ratios averaged 1 buck to 2.06 does. The ratio of adult does to number of young varied from 1.0:1.74 in favorable years to 1.0:0.66 during unfavorable periods. Average annual productivity was estimated to be 31 percent. Aerial census in 1956 indicated a preseason management area population of about 7,000 deer. The Lauckhart census showed a post season population estimate of

7,800 in 1958. This suggests a deer population of approximately 14,000 animals for the 2,000-square mile range.

Browse studies and rumen sample analyses show that Everglades deer eat a wide variety of plants (51 species identified) but about 10 species comprise the bulk of the year-round diet. These key forage species are *Nymphaea odorata* Ait., *Crinum americanum, Salix amphibia, Smilax* spp., *Jussiaea peruviana, Sambucus Simpsonii, Rivina humilis, Dicliptera assurgens* L., *Baccharis glomeruliflora* and *Osmunda regalis.*

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DISCUSSION

DR. MENDALL: Thank you, Mr. Loveless. We now know why this particular paper was placed on this panel, and I must say that I think it was justified. It is certainly evident that the people interested in the Florida deer have a lot in common with the people that are interested in waterfowl and other aspects of wetland ecology.

It is very interesting to note that the principal management that is applicable and that can be done for the Florida deer is based primarily on water control and regulation of water levels. Those of us who are concerned with waterfowl breeding ground productivity know that this is one of our major factors. We have that too. There is too little water, or the water gets there at the wrong season of the year, or it comes too much at one particular time.

MR. FRYE [Florida]: Charlie, I don't believe you dwelt at all on the food habits of the deer. I think that would be interesting.

MR. LOVELESS: Thank you. Our food habit studies have shown that the principal food of a white-tailed deer in this area, particularly during the winter period, is white water lily and swamp lily. We identified 51 species of plants that deer eat in this area, but about ten of these plants compose the bulk of the diet.

Our nutrition studies have shown, as in other areas, that the deer eat a wide variety of plants, but they choose relatively few for their primary sustenance.

The other plants that are eaten by the deer are principally the plants that occur on the tree island areas, such as elderberry and willow, and some of the West Indian herbaceous species. During the wintertime about 40 per cent of the diet is composed of white water lily and swamp lily.

MR. G. P. BUCARIA [California]: Do the number of air boats in the area restrict the number of hunters on that area in wet years, for instance?

MR. LOVELESS: Not as yet. However, each year more and more people are building air boats. These boats so far cannot be purchased commercially. Each hunter builds his own individual boat or has somebody build it for him. In the management area, in 1957, when the water was high, we estimated on opening day that there were about 500 air boats in the area, and it gets worse every year. Eventually we are going to have to do something about it because we will kill more hunters than we do deer. These machines at best are rather dangerous.

When you get 500 of them in one area—and there are no brakes on them, and they all run them as fast as they possibly can go—it is disturbing.

DR. MENDALL: I was a little surprised to learn that the average weight of your amphibious deer is about 120 pounds. To me, it seems that they must be doing pretty well, even in the face of what to us Northerners is a very unusual environment.

MR. LOVELESS: Along that line, we found that the year-round protein content of plants that the deer feed primarily on is around 20 per cent, and that even white water lily in that area is about 14 per cent. Some of the plants, West Indian herbaceous species on the tree islands, get up as high as 30 and 32 per cent protein content.

MR. L. STEINGARTEN [New York]: What if any are the natural enemies of the deer in this area?

MR. LOVELESS: We have no indications that there are any serious predators. We have a good population of bobcat in that area, but thus far we feel that they are feeding primarily on marsh rabbits. The only natural enemy as such is perhaps high water, if you want to look at it that, and man. We do get some disease and parasites, but it has not been serious.

LOW WATER AND LESSER SCAUP REPRODUCTION NEAR ERICKSON, MANITOBA

JOHN P. ROGERS[1]

University of Missouri, Columbia

We are aware of a rather close relationship between changes of water levels and of waterfowl numbers but very little is known regarding the exact way in which drought depresses reproduction. Recently another period of dry weather has occurred on the prairie breeding grounds, and it has been my good fortune to have had a study of breeding lesser scaup underway at the onset of low water. My observations show some ways in which the reproduction of the scaup was influenced by these changes. Because of current interest in the status of diving ducks, I believe this interim report on my studies worth discussing now.

THE STUDY AREA

My observations on the lesser scaup were made in 1957 and 1958 in the pothole country of southwestern Manitoba. This region is a 4000-square-mile block of rich agricultural land interspersed with many potholes. It contains some of the best waterfowl breeding habitat in North America. My work was done in the northern portion of this region on a one-square-mile study area two miles south of the town of Erickson. There are 20 potholes on the area—seven permanent and 13 semipermanent. In addition, there are seven temporary water areas. The potholes range in size from ½ acre to 25 acres and total about 135 acres. There are two potholes of 25 acres, one of 20 acres and three of ten acres, and they provide nearly all the permanent water on the area. The land here is intensively used for grazing cattle and for raising barley, oats and wheat.

Additional observations were made on Leda Lake (175 acres) on the west edge of the town of Erickson and Josepha Lake (150 acres) one mile northwest of Erickson.

The lesser scaup is the most abundant diving duck breeding in southwest Manitoba and ranks third among all species. Only the mallard and the blue-winged teal are regularly more plentiful. Aerial census data (Special Scientific Reports, U. S. Fish and Wildlife, 1947 to 1955) indicate that the relative abundance of the scaup has

[1]In the absence of the author, this paper was read by Dr. Frank McKinney.

remained essentially the same in this district since surveys were begun in 1947.

On the study area the scaup is the No. 1 breeding duck. In numbers of pairs it is nearly equal to all other species combined.

WATER LEVELS IN 1957 AND 1958

Water levels on the study area in 1957 were high. When I arrived on the area in mid-June, water was outside of the basins of most of the potholes. The emergent vegetation at the edges of the potholes was flooded, and the grass-sedge borders surrounding the potholes contained standing water extending as far back as 50 or 60 feet from the edge.

Water levels declined slowly but steadily during the season, causing the drying up of the peripheral flooded areas—an event which was not completed until late July or August. The potholes themselves remained full, or nearly so, throughout the season, and only the temporary areas and a few of the smaller semi-permanent potholes became dry.

In 1958 water conditions were very different. Rains during the previous autumn had been light and the snowfall was below normal. Very little run-off water, therefore, was added to the potholes. When I returned to the study area in mid-April, 1958, the water levels appeared to be essentially the same as when I left in September. Precipitation remained light and water levels dropped rapidly as the weather warmed. By May 30, water was about eight inches below the April level and by June 30, it was down 18 inches. By September 1, the water had fallen to 2 or 2½ ft. below April levels.

The number of potholes was also drastically reduced during the season. By the end of June all temporary areas and eight of the thirteen semipermanent areas had dried up. On September 1, only eight potholes still held water. Even in these the peripheral stands of sedges and grasses were bone dry by June 1, and by June 30, a widening flat of exposed mud had appeared between water's edge and emergent vegetation.

The appearance of Leda Lake was similar, but on Josepha Lake the situation was drastically changed by partial drainage. On July 22, 1957, a ditch was dug from the lake to the Rolling River, resulting in the lowering of the water by six feet, leaving it 4 to 5 feet deep. The water area was reduced by one-half. By mid-August of 1958, after much evaporation had taken place, the maximum depth was 30 inches and most of the lake was only 8 to 15 inches deep. The drainage alone resulted in leaving all emergent vegetation dry and exposing an area of bare mud 20 ft. to 60 ft. wide. Additional water losses due to evaporation widened the span of bare mud.

BREEDING PAIRS AND PRODUCTION IN 1957 AND 1958

Weekly counts of breeding pairs and broods on the study area and the lakes were made from the ground.

I did not arrive on the study area until mid-June in 1957, when pairs of most species had already broken up. The lesser scaup, however, does not begin nesting until early June so I could make pair counts for this species. There were 51 pairs of scaup on the study area, and they produced a minimum of 25 broods containing 225 young. The brood count is not exact because scaup broods tend to aggregate on the bigger potholes. However, at least 50 per cent of the pairs observed on the study area produced young.

Pair counts on Josepha Lake and Leda Lake were not satisfactory because of the size of the lakes and the coming and going of pairs typical on large waters. I did make reliable counts of young and they showed about 325 young scaup on Josepha Lake and 200 on Leda Lake. Aggregation of broods was even more pronounced here, but there were at least 33 broods on Josepha Lake and 20-25 broods on Leda Lake.

In 1958, there were 65 pairs of scaup on the study area, an increase of 29 per cent over 1957. The first searching for nest sites by female scaup was seen on the morning of May 29. This activity became increasingly common in June and gave the appearance of normal progression of the breeding cycle. In the last half of June, however, I noticed that the number of pairs sitting on the potholes during the day was not decreasing, but remaining constant. This was the first sign of abnormality in the nesting season. Where in 1957, lone waiting drakes were common in June and July, few were seen in 1958, but pairs were common until mid-July. In fact, on Leda Lake, there was a June increase in pairs. As these pairs remained common until mid-July (quite unlike 1957) I suspect that most of them were unsuccessful pairs that had given up nesting.

The first brood did not appear until July 24, about three weeks later than in 1957. The total production on the study area was only 3 broods containing 20 young, a 91 percent decrease.

I do not know how many pairs attempted to breed on the lakes, but no nests were found on Josepha and no signs of nesting activity were seen. No broods of any species were seen here in 1958. Only one scaup nest was found on Leda and the only scaup brood found here was 1½ weeks old on August 24. For both lakes together there was a 98 per cent decrease in production.

Additional evidence of decline in production was gathered on two ground transects near Erickson. The first one was a 28-mile circuit outside the study area. The second ran west from Erickson for 27 miles. Water conditions on these transects were similar to those on the study area in both years. On these two transects 23 broods (183 young) were found on August 6 and 15, 1957. On August 10 and 11, 1958, only three broods (27 young) were found. This is a decline of 85 per cent.

My observations of other species of diving ducks on the study area and on Josepha and Leda Lakes show that their production also declined. The canvasback went from 8 broods (67 young) in 1957, to 4 broods (28 young) in 1958; the redhead from 10 broods (79 young) in 1957, to 1 brood (8 young) in 1958; the ruddy duck from 11 broods (83 young) in 1957, to no young seen in 1958.

I do not have reliable figures on surface feeding ducks because special effort must be made to find their broods, and my study was not designed to do this. However, I found twice as many broods in 1958 as in 1957. This may have been due in part to more intensive coverage for a longer period in 1958. The increase was nearly all in broods of blue-winged teal and pintails. This increased production in blue-wings and pintails may be evidence of a successful population shift in these species. There was a marked May arrival of river ducks into Manitoba, presumably birds that had shifted eastward from areas completely dried out in Saskatchewan (Hochbaum, pers. comm.). The number of mallard broods seen, however, was the same for both years in spite of more intensive coverage. In any event, my meager data on river ducks suggests that, locally, their reproduction is not as greatly restricted by the early stages of water level decline as is that of diving ducks.

FACTORS CAUSING THE DECLINE IN PRODUCTION

The most important factor in the abrupt decline in production of the lesser scaup was the drop in water levels. The decrease in water levels, however, appeared to operate indirectly by increasing the effects of other adverse factors. Most important of these was nest predation. The fate of 26 nests found on the study area is shown in Table 1. Here it can be seen that 80 per cent of all nests were

TABLE 1. THE FATE OF 26 LESSER SCAUP NESTS FOUND ON ONE SQUARE MILE IN 1958.

Destroyed by predators	21 nests
Stepped on by cattle	2 "
Destroyed by mowing	1 "
Abandoned	1 "
Hatched	1 "

destroyed by predators. Most of these were ground predators and I found only three nests destroyed by crows. When the peripheral grass-sedge cover around the potholes and the emergent vegetation at the edges dries up, the nests in these areas are apparently much more vulnerable to predation. This is probably due to increased accessibility of the cover for predators and because the trails left by females going to and from their nests are more easily found.

Other adverse factors associated with low water levels are grazing of cattle and hay mowing. Neither of these were very important on the study area. Only three potholes were consistently grazed, and only one was mowed. Both nests destroyed by cattle were on one pothole where grazing was particularly heavy. Both grazing and mowing, however, increase with dry weather, especially if cultivated hay is in short supply. They may influence the predation rate by reducing cover and creating easily followed trails through it.

But predation and agriculture are only part of the story. I found little evidence of renesting. We know very little about renesting in diving ducks, but, in normal years, renesting must account for some production. In 1958 neither intensive nest hunting nor constant observation of pairs suggested much renesting. Two marked females which lost their nests after incubation started did not attempt to nest again. Failure to renest, of course, exaggerates the effect of predation and agriculture.

It is possible that lowering water levels may have a direct inhibitory effect on nesting. On Josepha Lake many broods of scaup and other species were produced prior to partial drainage in 1957. In 1958, when water levels had drastically changed, no broods were found. I observed no nesting activity even though the lake had relatively high usage by many species of ducks throughout the season. I suspect that nesting was also inhibited on the study area but I have no measurement of it there. If there is inhibition, I believe that the bird's behavior is strongly influenced by the retreat of water from the emergent vegetation which is left dry and isolated by bare mud flats.

THE FALL BAG CHECK

In view of the situation on my study area in 1958 I was interested in measuring the impact of hunting on the lesser scaup and other diving ducks. Because of the difficulty in getting an adequate bag sample in the pothole region, and because large numbers of ducks can be examined at Delta I worked there. Nan Mulder and I, with assistance from other members of the Delta staff, examined 4,765 ducks (see Table 2).

TABLE 2. COMPOSITION OF THE 1958 BAG SAMPLE AT DELTA, MANITOBA.

	Adult		Immature			
	Male	Female	Male	Female	Unaged*	Total
Lesser scaup	361	384	420	545	49	1759
Mallard	387	298	283	282	51	1301
Canvasback	27	55	112	113	4	311
Green-wing teal	41	35	122	87	....	285
Pintail	73	57	65	77	10	282
Blue-wing teal	30	58	45	40	....	173
Gadwall	31	27	40	52	3	153
Widgeon	13	25	40	47	....	125
Redhead	13	13	38	49	4	117
Shoveler	10	25	23	36	....	94
All others	....	....	....	....	....	165

*Not examined for sex and age.

From the data it can be seen that the lesser scaup was the No. 1 duck in 1958, eclipsing even the mallard. This never occurred in 14 previous bag checks at Delta during the past 21 years when it ranked third or fourth. The redhead was uncommon in the 1958 Delta bag and ranked 9th as compared to its No. 4 position for the years 1938-1950 (Sowls 1955). The canvasback was No. 3 in the bag even though some sportsmen at Delta announced that they would not shoot this species. Because these last two species migrate earlier than the scaup, few were killed after mid-October. Table 3 shows the weekly kill of scaup, redhead and canvasback and this closely follows the trend in the numbers of each present during the season.

Although there are no year-to-year population counts at Delta for comparison of numbers I believe the larger kill of scaup in 1958 was due to concentration of both ducks and hunters. This was caused by the drought which had reduced the Delta Marshes to one-half of their 1957 area. This restriction of area and crowding of hunters caused mallards, on the other hand, to become extremely wary (see below) and more difficult to bag. As a result scaup were frequently shot as a less desirable substitute. I met many hunters bringing in bags of scaup with the comment: ''That's all there is to shoot today.''

From observations made during the bag check it was apparent that scaup were highly vulnerable to shooting as long as they were present

TABLE 3. COMPOSITION OF THE KILL AS SHOWN BY THE BAG ON OPENING WEEK-END AND SUBSEQUENT WEEKS OF THE 1958 HUNTING SEASON AT DELTA (NO SHOOTING ON SUNDAY).

	Sept. 19-20	Sept. 22-27	Sept. 29-4	Oct. 6-11	Oct. 13-18	Oct. 20-25	Oct. 27-1	Nov. 3-8	Nov. 10-15	Total
Mallard	263	346	234	147	112	100	22	7	70	1301
Canvasback	8	77	72	65	55	21	8	1	4	311
Redhead	22	35	30	16	8	4	2	0	0	117
Lesser scaup	0	46	212	369	560	308	136	7	120	1759

on the marsh. The same stands and blinds yielded limit bags day after day. The mallard kill on the other hand showed a steady decline even though mallards remained abundant throughout the season. Unlike the scaup, the mallard kill figures in Table 3 do not follow the population trend. They responded to hunting pressure by becoming increasingly wary, coming into the marsh at night or flying out to stubble to feed and spending the day on the lake where they were undisturbed.

The ratio of young per adult female in the bag of canvasback, redhead and lesser scaup is shown in Table 4. For each of these species the ratios were considerably lower in 1958 than in previous years. I do not have similar data on the mallard for past years but Sowls (1955) gives an average figure for the period 1938-1950 of 3.5 young per adult female. In 1958, the ratio was only 1.9 young per adult female. Table 2 shows that more adult than young mallards were bagged, the first time adults have outnumbered young in any Delta bag.

TABLE 4. AGE RATIOS IN THE DELTA BAG EXPRESSED AS NUMBER OF YOUNG PER ADULT FEMALE. SAMPLE SIZE IN ( ).

	1938-1941[1]	1946[2]	1952[3]	1958
Canvasback	8.2 (774)	17.0 (1370)	7.2 (288)	4.1 (310)
Redhead	23.3 (266)	16.6 (601)	.... (123)[4]	6.7 (100)
Lesser scaup	6.7 (664)	9.2 (224)	6.9 (513)	2.5 (1349)

[1]Hochbaum (1944). [2]Sowls (1955). [3]Weller (unpublished ms.). [4]No adults checked.

I make no attempt to interpret these ratios. The bag is from only one area. We know little about selective hunting pressure against young birds in the diving ducks. We also know little about the age composition of the population on the marsh. How these special 1958 conditions: low young per adult female ratios; a heavier kill of adult rather than juvenile mallards; and the lesser scaup becoming, for the first time, the most heavily shot species, tie in with dry breeding marshes is little more than speculation at this time. I offer this bag record only as a small step toward ultimate understanding of the bag study as a tool for measuring the condition of a waterfowl population.

SUMMARY

In the spring of 1957, water levels were high in the potholes near Erickson, Manitoba and 51 pairs of lesser scaup on a square mile study area produced 225 young. Subnormal precipitation during the following winter left water levels low at the onset of the 1958 breeding season. Peripheral nesting cover, flooded in 1957, was dry in 1958,

and emergent shoreline vegetation was separated from water by mud flats. On the same square-mile study area, 65 pairs produced only 20 young. Low water levels and reduced production were also observed on two nearby lakes and on two transects crossing the district. Reduced production was observed in other diving ducks, but river ducks showed no evidence of this.

Greater vulnerability of nests to predators and failure of birds to renest in dried-out edge cover probably account for the severe decline in production of lesser scaup.

A bag talley of 4,765 ducks shot on the Delta Marsh shows that the lesser scaup was the No. 1 bird in the bag, probably because of its greater accessibility in a marsh reduced by drought. The ratio of young per adult female was smaller than in any other year in lesser scaup, redhead, canvasback and mallard. For the first time, adults outnumbered young in the mallard bag. The diving duck kill was proportional to populations on the marsh. In the mallard, however, the kill declined as the season advanced despite a continuing high resident population.

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DISCUSSION

DR. HOWARD MENDALL: Thank you, Frank. Once again we see the effects of water levels as an important factor in management of wetlands. Water that is too high in one part of the country for proper management, for proper welfare of the species concerned, is exactly the opposite elsewhere.

Perhaps some of the hunters of the East, particularly, who have heard that paper, can better appreciate the viewpoint of the people in Washington who are charged with making the federal regulations in their anxiety of what happens in the Prairie Provinces, as far as precipitation and runoff is concerned.

There are a lot of biological implications in this paper, which certainly have a bearing on management, and I am sure that some of you who are interested in similar types of habitat programs must have some questions that you would like to ask Dr. McKinney.

There is one question I would like to ask. I realize you did not do the study. Do you feel that the results, particularly from the renesting standpoint on this study area, are applicable over a fairly extensive area? That I think you will agree is very important in management, from the standpoint of annual production. We have come to realize more strongly all the time how much under certain conditions we are dependent on renesting for our ultimate production.

You heard some rather depressing figures on that particular aspect, and I wonder if you would like to enlarge on them just a bit.

DR. MCKINNEY: I probably know how John Rogers would answer that question. This study was done on one area, and he does not know what happened anywhere else.

His evidence on renesting is somewhat circumstantial, although he had two marked birds which lost their nests and did not renest. I know he would hedge the question by saying, "I will not generalize as to other regions." I believe that he would say, "We must have more careful studies on small areas of this sort, and then perhaps it would be possible to generalize."

DR. MENDALL: This is very clear as an example of how research can have immediate application in management and how much it is needed on a regional basis. What happens in one place is not necessarily what is going to happen elsewhere. Yet, there are implications involved that could be serious, if they took place over a very extensive part of the breeding range of some of our different duck species, and would explain why we get such sudden and abrupt population fluctuations down through the flyways. Would anyone like to comment?

MR. YOUNG [Wisconsin]: If I interpret your remarks correctly, as water areas dried up, you had birds concentrating on the remaining water areas. These birds remained as pairs rather than going into the flock category. Do you have any indication that because of increased density of breeding pairs there therefore was a lack of total breeding effort? In other words, was space involved in here, or did territory enter into the decreased successful breeding effort?

DR. MCKINNEY: I don't see how we can answer that. I don't believe that John Rogers had much evidence on this point.

We will need other data to support before we can draw far-reaching conclusions, and I don't think he could answer that question.

MR. YOUNG: Let us just take it one step backward. Am I correct that when these birds did concentrate in the remaining water areas that they did remain in pairs?

DR. MCKINNEY: Yes, he was seeing pairs later in 1958, more pairs than in 1957.

MISS HELEN HAYS [New York]: I wondered if the aerial transacts were run during these years, and if the totals they got or the breeding counts reflected a similar pattern to what he found on his small area.

DR. MCKINNEY: Do you mean, did the aerial surveys over the past two years show this? I am afraid I can't answer that.

ANGLING SUCCESS AND SEASONAL DISTRIBUTION OF CATCH IN ALABAMA'S STATE-OWNED PUBLIC FISHING LAKES

I. B. BYRD

Alabama Department of Conservation, Division of Game and Fish, Montgomery

Fishery departments of many states having areas with insufficient fishing waters have considered construction of artificial lakes to meet these needs. Numerous pertinent questions regarding such a program immediately arise. Can good fishing be produced in such lakes? Will they support sustained fishing over a period of time each year, or will they be "fished out" in a few days or weeks? Can these lakes be managed to produce good fishing for bass and other fish over a period of years, or must they be drained and restocked at frequent intervals? And, can they be managed and operated at a reasonable cost?

The experiences of the Alabama Department of Conservation in the construction and management of 12 public fishing lakes offer partial answers to many of these questions for the Southeast. These lakes varied in size from 32 to 250 acres. They were stocked with bluegills *(Lepomis macrochirus)*, redear sunfish *(Lepomis microlophus)* and largemouth bass *(Micropterus salmoides)* as suggested by Swingle (1949, 1951, 1952), and fertilized and managed as recommended by Swingle and Smith (1947). Balance was measured several times annually by the method for pond analysis described by Swingle (1956). Overcrowding was corrected by marginal and/or sectional poisoning with rotenone (Swingle, Prather and Lawrence, 1953).

Byrd and Moss (1956), in summarizing the methods of management used and production obtained from 11 of these lakes from 1950 to 1955, reported that each acre supported an average of 189 fishing trips and yielded an average catch of 180.9 pounds of fish annually. The average annual catch of bass during the 5-year period was 27.6 pounds per acre.

As the lakes have aged, further information has been obtained. Information regarding fishing success, seasonal distribution of catch in old and new lakes, trends in annual yields as the lakes aged, and costs of operation are reported in this paper.

ANGLING SUCCESS

The 12 state-owned lakes were usually first opened to fishing in June or July of the year following stocking and then remained open

TABLE 1. SUMMARY OF THE AVERAGE NUMBER OF FISHERMAN-TRIPS AND AVERAGE ANNUAL CATCH OF FISH PER ACRE FROM STATE-OWNED FISHING LAKES OPEN TO FISHING FOR 2 TO 8 YEARS

Name of Lake	Area (Acres)	Number of years open to fishing	Average annual number of fisherman-trips per acre	Average annual catch per acre: Sunfish[1] Number	Sunfish[1] Pounds	Largemouth bass Number	Largemouth bass Pounds	Bullhead Number	Bullhead Pounds	Crappie Number	Crappie Pounds	Total Number	Total Pounds
Tuscaloosa	250	2	150	496	159.1	54	38.8	....	....	....	....	550	197.9
Barbour	75	5	143	739	139.3	15	11.3	3	0.3	....	....	757	150.9
Lamar	68	5	116	528	133.6	32	24.6	62	17.7	....	....	622	175.9
Marion	45	5	141	417	110.4	67	48.1	7	3.2	....	....	491	161.7
Pike	45	5	133	299	74.8	36	25.5	80	67.0	....	....	415	167.3
Marengo	40	6	89	353	115.4	33	27.4	....[2]	0.3	....	....	386	143.1
Clay	51	7	240	282	104.8	56	50.9	....	....	....	....	338	155.7
Coffee	80	7	158	746	161.1	29	29.3	9	6.3	....	....	784	196.7
Cullman	32	7	242	549	119.3	11	14.7	9	2.2	....[2]	0.1	569	136.3
Butler	42	8	152	296	94.2	36	32.0	4	3.7	....	....	336	129.9
Crenshaw	53	8	208	1050	220.7	10	19.1	3	2.3	19	6.1	1082	248.2
Fayette	60	8	159	383	128.2	39	30.7	5	3.3	....	....	427	162.2
Averages	70.1	6.1	162	541	137.1	35	29.5	13	7.0	2	0.6	591	174.2

[1]Bluegill and redear sunfish. [2]Less than 0.5.

the year-round during daylight hours. The opening, therefore, was about 18 to 19 months after the bluegill and redear sunfish were stocked and approximately 13 to 14 months after the largemouth bass were planted. There were no size limits and the usual creel limit was 20 bluegill or redear sunfish and 6 largemouth bass per fisherman-trip. Although the exact length of the fisherman-trip was not determined, estimates obtained from spot checks during various seasons of the year indicated that each angler fished about 3.5 hours per trip. Daily records of the number of fishermen and the numbers, weights and species of all fish caught were obtained by resident lake managers.

The 12 lakes contained a total of 841 acres; three of these lakes totalling 155 acres, have been open to continuous fishing for 8 years, 3 containing 163 acres for 7 years, 1 with 40 acres for 6 years, 4 containing 233 acres for 5 years and 1 with 250 acres for 2 years. By multiplying the acreage of each lake by the number of years fished and then adding, it was found that these lakes furnished a total of 4,286 acre-years of fishing during the period of 1950 to 1958. During this time, a total of 695,282 fishermen caught 2,530,182 fish weighing 746,598 pounds.

The average annual results per acre for all lakes (Table 1) are summarized as follows:

Item	Range	Average
Number of fisherman-trips	89-242	162.2
Pounds of all fish caught	129.2-248.2	174.2
Pounds of bluegill and redear sunfish caught	74-8-220.7	137.1
Pounds of bass caught	11.3-50.9	29.5
Pounds of bullhead caught	0.0-67.0	7.0
Pounds of crappie caught	0.0-6.1	0.6

The only lakes providing significant catches of bullheads *(Ictalurus natalis* and *Ictalurus nebulosus marmoratus)* were Lamar and Pike Lakes which had an average annual catch per acre of 17.7 and 67.0 pounds, respectively. The bullheads apparently survived the rotenone treatments made prior to the stocking of lakes. Only two lakes (Cullman and Crenshaw) contained crappie *(Pomoxis annularis* and *Pomoxis nigromaculatus)*. The crappie apparently were stocked in these lakes by unknown individuals sometime during the latter part of the fifth year that they were open to fishing and began to show up in the anglers' creels during the sixth year of fishing. The crappie were evidently repressed by the existing fish population in Cullman Lake; they were more successful in establishing themselves in Crenshaw Lake where the average annual catch was 6.1 pounds per acre.

The low catch of bluegill and redear sunfish in Pike Lake probably was caused by competition from bullheads since the average annual catch of bullheads from this lake was 67.0 pounds per acre and the combined average annual catch of bluegill, redear sunfish and bullheads was 141.8 pounds per acre. The catch of bluegill and redear sunfish from Marengo, Clay, and Butler Lakes declined during the last three years, following treatment of these lakes with sodium arsenite at a concentration of 4 p.p.m. As_2O_3 to control a summer alga (*Pithophora* sp.). Similar reductions of fish populations following treatments of experimental ponds with sodium arsenite were reported by Lawrence (1957).

It is evident from the above results that the managed artificial lakes were highly productive and that bluegill, redear sunfish, and largemouth bass furnished most of the catch. The average annual yield of 174.2 pounds per acre compared favorably with yields from fertilized experimental ponds (Swingle 1945, 1952) and were much higher than those reported from other lakes (Bennett, 1954; Eschmeyer, 1935; Pelton, 1950; Thompson and Hutson, 1951).

FISH CATCH DURING FIRST THREE MONTHS FOLLOWING INITIAL OPENING OF LAKES

The conditions prevailing in the fish populations at the initial opening of these new lakes to fishing were unique in the life of the lakes. Definite numbers of fish were stocked into virgin waters, and no fishing was allowed for the succeeding 13 to 18 months. Consequently, upon the opening date, a large weight of inexperienced and unsuspecting fish of harvestable size was present per acre. Fish were very readily caught, and as a result large crowds of fishermen were attracted to the new lakes as soon as they were opened to fishing. In one lake, the catch on opening day was 58 pounds per acre. The rapid withdrawal of large weights of adult fish within a few days placed quite a strain upon the population in the maintenance of balance and the replacement of harvestable stocks.

The average catch per acre during the first 12 weeks following the initial opening of the 12 lakes to fishing is shown in Figure 1. The average catch per acre for the first day, first week and first month was 26.9, 74.5 and 105.4 pounds, respectively. Therefore, the first day's catch made up about 34 per cent of the first week's catch, about 26 per cent of the first month's catch and 12 per cent of the first year's catch. In general, the total catch declined sharply during the first 7 days and then declined gradually before leveling off after about four weeks. About 56 per cent of the opening year's catch for all lakes was taken during the first three months after the lakes were

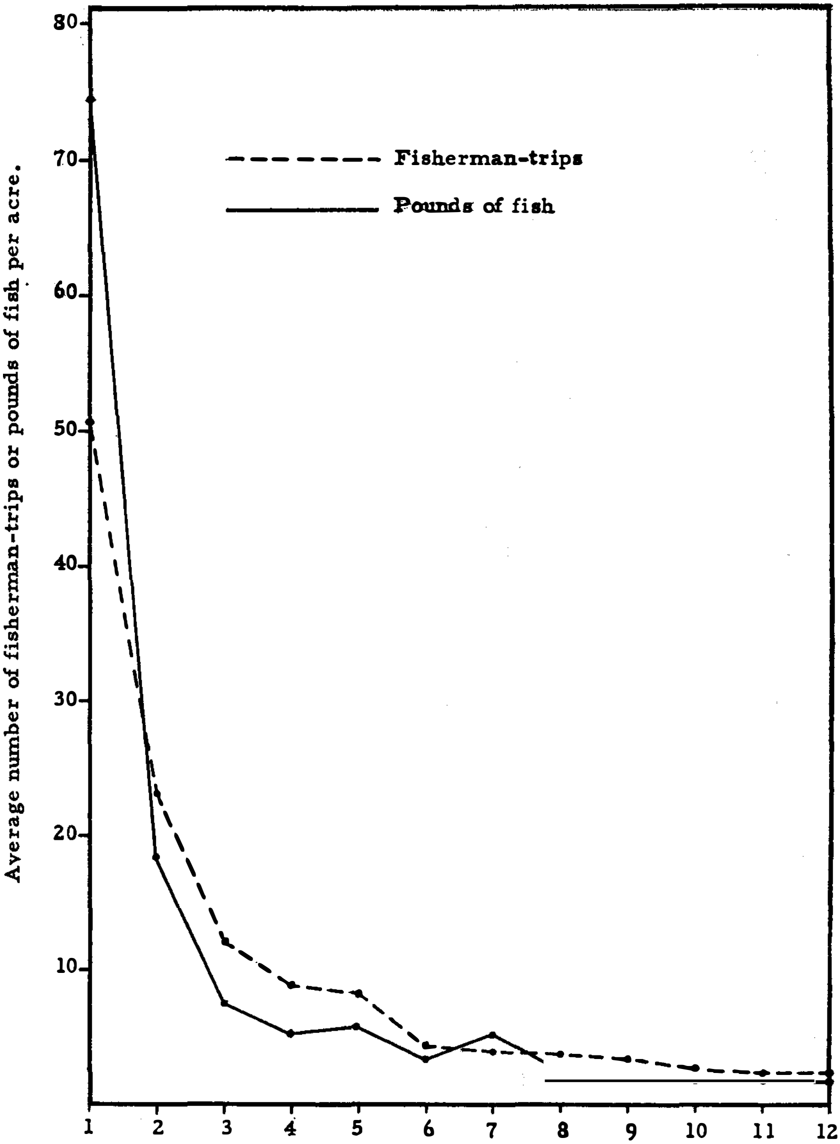

Figure 1. Average number of fishermen and average catch per acre during the first 12 weeks after the initial opening of state-owned lakes.

opened to fishing. The primary reason for the rapid decline in catch appears to have been the vast reduction of the standing crop of harvestable fish. To some extent, the rapid decline may have been partially due to the fishes' increasing knowledge of fishermen and baits as suggested by Aldrich (1938), Bennett (1954) and Bowers and Martin (1956).

These same conditions do not occur again during the life of the lake. When the lakes are open to continuous fishing, harvest and recruitment to the harvestable stocks occur simultaneously. At no other time does the population contain such a high percentage of harvestable fish as on the initial opening day, nor are the fish as easily caught.

SEASONAL DISTRIBUTION OF THE FISH CATCH

In order to eliminate bias caused by the large initial catches of fish by fishermen immediately after the opening of a new lake, the fish catch during the first three months following the opening of each lake was excluded from the fish-catch data before they were analyzed to determine the average seasonal distribution of catch. The average annual number of fisherman-trips and average annual poundage of fish caught per acre were determined for all 12 lakes for each of thirteen 4-week periods (Figure 2). To simplify the discussion of fish catch by seasonal period, each 4-week period will be referred to hereafter by indicating the month in which most of the fish catch for a particular period was obtained.

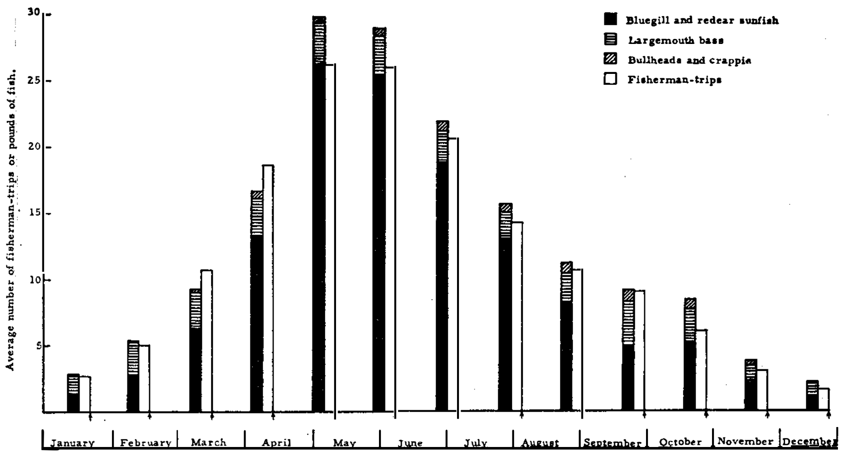

Figure 2. Average seasonal catch and average number of fisherman-trips per acre in 12 state-owned lakes open to year-round fishing.

The number of fishermen and the total poundages of fish caught increased gradually from January to May, with a peak in May and June, and then decreased gradually from June to December. The smallest number of fishermen and the smallest total catch occurred during the months of November, December and January.

The seasonal distribution of the catch of bluegills and redear sunfish was more pronounced than that of bass. The greatest poundages of bluegill and redear sunfish were taken during the months of April to September with peak catches occurring in May and June. The smallest poundages of bluegill and redear sunfish were caught during November, December, January, and February.

The seasonal catches of bass were fairly well divided between 10 of the thirteen 4-week periods with slightly larger catches occurring during April, May, June and September. The smallest catches of bass were recorded in November, December and January. However, the poundages of bass caught during these three months were about equal to the combined poundages of bluegill and redear sunfish taken.

In general, bullhead and crappie contributed little to the catch. The largest poundages of these species were taken during August and September.

It is interesting to note that the average annual catch of fish per fisherman-trip for each of the thirteen 4-week periods remained somewhat constant (Figure 3). However, the catch per fisherman-effort was greater during fall and winter months than it was during the spring and summer. Therefore, angling success per fisherman-trip

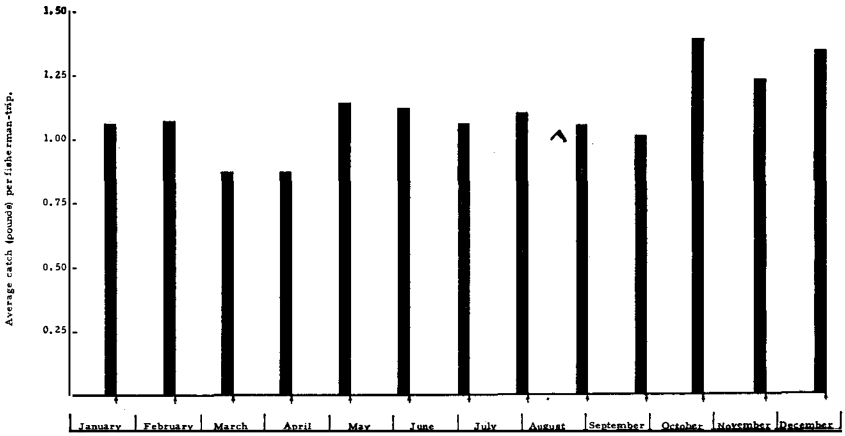

Figure 3. Average seasonal fishing success expressed by the average catch per fisherman-trip in 12 state-owned lakes open to year-round fishing.

was best during the seasons having the smallest number of fishermen and lowest total catch. Probably the most logical explanation for the larger catch per fisherman-effort during the "off-seasons" was that most of the fishermen who fished during the fall and winter were "specialists of the trade" while the neophite fishermen waited until the warmer seasons to try their luck. Since bass made up a larger percentage of the total catch during the winter months when there were fewer fishermen and a lower total catch of fish, it may be that the fisherman had a better opportunity to catch more fish, especially bass, because there was less fisherman-activity on the lakes.

The results given in Figures 2 and 3 show that artificial lakes when properly managed do produce fishing distributed satisfactorily throughout the year. The lakes were not "fished out" within a few days or weeks, even with an average fishing pressure of 162 fisherman-trips per acre per year.

CHANGES IN THE AVERAGE ANNUAL CATCH AS LAKES AGED

Can artificial lakes stocked with bluegills, redear sunfish and large-mouth bass be managed to produce satisfactory fishing over a long period of years? In many areas, it is assumed that this is impossible and that frequent draining is necessary to provide good fishing.

The annual average catches from the 12 Alabama state-owned lakes for the 8-year period covered by this report are shown graphically in Figure 4. With the exception of the first year following the opening of the lakes, the average catch of fish per acre remained relatively stable for each succeeding year, up to eight years of fishing. There was no general decline in fish catch during the 8-year period. In fact, the average catch of fish per acre during the eighth year exceeded the average catch taken during each of the second, third, fourth and seventh years that the lakes were opened to fishing.

During the first year, the average number of fisherman-trips per acre was 194 and the fishermen caught an average of 744 fish weighing 223.9 pounds per acre. This accelerated fish catch would be expected during the first year of fishing since the fish caught would be a part of two years of production; that is, the production during the year following stocking and prior to opening and the production during the first year of fishing following the date of opening.

In general, the average catch of bass for each of the 8 years also remained fairly stable, varying from a low of 22.1 pounds per acre in the eighth year to a high of 36.1 in the sixth year. The slight drop in the average bass catch during the eighth year was probably caused by the competition of crappie which provided an average catch of 10 pounds per acre. The combined average total catch of bass and

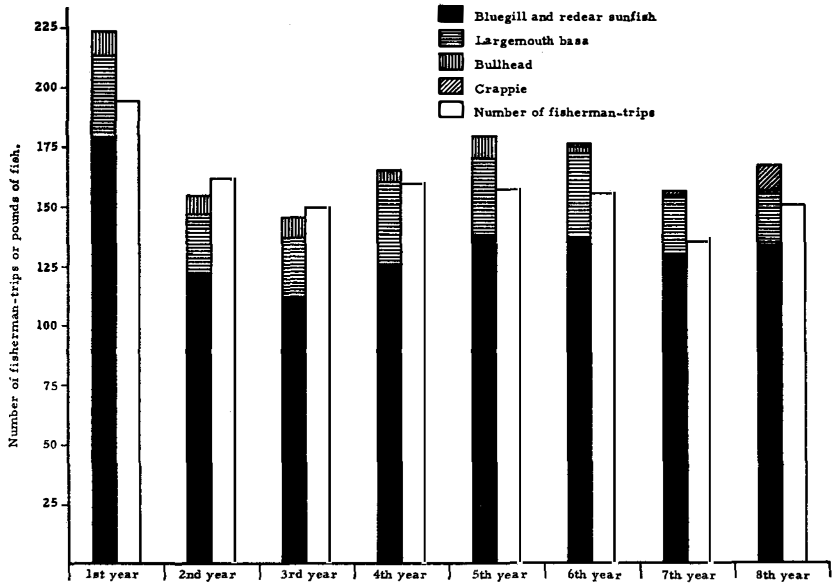

Figure 4. Average number of fisherman-trips and average catch per acre for each of the 8 years that Alabama's state-owned lakes have been open to fishing.

crappie taken per acre during the eighth year was 32.1 pounds.

The bullhead population declined annually following the first year of fishing. The average catch of bullheads per acre was 11.6 for the first year and 1.5 for the eighth year of fishing.

These results indicate that artificial lakes stocked with largemouth bass, bluegill and redear sunfish, produced satsfactory annual crops of fish over an extended period of years without draining when the proper management techniques were applied.

COSTS AND REVENUES

Experience in the operation of these lakes demonstrated that they produced satisfactory fishing well distributed throughout the year, and that good fishing could be maintained by proper management throughout an 8-year period. It is, therefore, important to consider the costs of management.

Income from the lakes was derived from the sale of daily fishing permits at 50 cents to all fishermen above 16 years of age, sale of boat permits at $1.00 per day, and the sale of concessions. The annual gross income per acre averaged $143.00 of which $81.00 was derived from fishing permits, $33.00 from boat permits, and $29.00 from concessions. After subtraction of costs of fertilization, population and weed control, boats, maintenance, concession items, and payments to lake managers, the net return was approximately $12.00 per acre annually.

The charge of 50 cents per fishing permit and $1.00 per boat permit covered adequately the annual costs of operation of these lakes, but did not repay the original cost of construction ($480 per acre) and interest on the investment. If these costs are to be recovered, a charge of 75 cents to $1.00 per fishing permit would be necessary.

SUMMARY AND CONCLUSIONS

The construction of lakes by the Alabama Department of Conservation was initiated to provide fishing in those areas of the State having insufficient public fishing waters. The lakes were constructed on carefully selected sites so they could be fertilized and otherwise managed to provide high sustained yields of fish. The lakes were stocked with bluegill, redear sunfish and largemouth bass.

Twelve state-owned lakes containing 841 acres were open to fishing for 2 to 8 years, providing a total of 4,286 acre-years of fishing. During this time the lakes provided a total of 695,282 fisherman-trips in which the fishermen caught a total of 2,530,182 fish weighing 746,598 pounds. The average annual number of fisherman-trips per acre for all lakes was 162.2 and the average annual catch per acre was 590 fish weighing 174.2 pounds. The lakes provided a year-round fishery with satisfactory seasonal distributions of catch. Although a larger total catch was taken during the spring and summer, the catch per fisherman-effort was somewhat higher during the fall and winter.

After an average first year catch of 223.9 pounds of fish per acre, the average yearly catch per acre remained relatively stable, varying from 144.5 to 179.0 pounds per acre for periods up to 8 years. This evidence disproves the popular belief that lakes stocked with bass and bluegill always become unproductive after the first year they are open to fishing.

The construction of public lakes appears to be a practical method of providing good fishing in areas of the Southeast having insufficient fishing waters. Large annual yields of fish can be produced in lakes when they are fertilized and otherwise managed to maintain balanced fish populations.

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DISCUSSION

DR. MENDALL: Thank you, Mr. Byrd. Even a duck man can be affected by a fish presentation as effective as that one. I only wish we knew how to manage ducks and duck hunters as well as the people in Alabama appear to be able to manage fish and fishermen.

I would not presume to attempt to lead a discussion on fish, so I am going to ask Bob if he will pinch-hit for me.

CHAIRMAN PAUL: Some of the data Buck has here are striking. They contrast with the general history of unmanaged waters, the initial splurge of good fishing and the tapering off that is so typical of many of our reservoirs. It is a good argument for management, and I cannot help but think that the revenue-producing aspects of this, and the way the State of Alabama has poured their money from fees back into management is a pretty good lesson for the arid states and other states where there are no waters that produce natural fishing.

DR. HAZZARD [Harrisburg, Pennsylvania]: How much land do you insist on being given around the perimeter of the lake that is constructed? Can the property owner control frontage, or do you take 200 feet or 300 feet or more from the margin of the lake you created?

MR. BYRD: In many of these lake areas, and particularly some of the first ones, we required the entire drainage area. Since that time we have become a little more lenient. However, we do require plenty of land for all of the buildings we need, concession buildings, picnic areas, and so on; but we require now a minimum of at least 300 feet immediately adjacent to the shoreline of the lake.

DR. HAZZARD: Thank you. I was interested in the average production. Could you tell us the range in the production in these lakes?

MR. BYRD: The range in product was from 129.2 to 248.2 pounds per acre annually.

DR. HAZZARD: How soon after stocking was fishing opened, and also what size fish did you stock?

MR. BYRD: We stocked in the fall with fingerling bream, usually 2 to 3 inches and with fingerling bass, 1 to 2 inches in the spring. The lakes were opened to fishing about one year after the time they were stocked with bass. They were usually opened to fishing in June or July and were stocked with bass usually in April or May.

MR. RICHARD STROUD [Sport Fishing Institute]: This is one of the more encouraging papers I have heard in a long time, as far as fish management reports are concerned. It really raises and answers some very basic questions, such as how long is this fishing sustained, year after year; is it a flash in the pan seasonally, and what will it cost? I think you have done a fine job. I would like to say that in my opinion, this well illustrates the thing that has been said many times to the effect that good fishing just doesn't happen any more. It has to be created. This is a very good illustration in my opinion, which might be characterized as a dividend of research.

I think the point should be made that this system that you have developed to such a high degree in public fishing in Alabama is based on a prior 20-year period more or less of very intensive research, both empirical and experimental, in the southeastern area, principally at Alabama Polytechnic Institute.

I have noticed that in many of the studies in the Southeast, we are at a point where we can summarize bass production. Recently we did this out of curiosity, and we noted that about 60 to 65 pounds per acre was the general average of bass production in managed ponds in the Southeast. This is about a third higher than the production in unmanaged ponds.

Your harvest, I noted, was about 30 pounds per acre. This suggests that you may be cropping off the bass at approximately 40 to 45 per cent ratio, which is much higher on a sustained yield than we have noted almost anywhere else in the country. I think that is very significant. I just wonder whether you have any direct measure of the percentage rate requirements, whether my appraisal is a satisfactory one in your opinion.

MR. BYRD: As of this time we haven't put too much confidence in the estimate of standing crops. We are really concerned with getting fishing for the fishermen.

MR. GUS PREVOST [Montreal, Canada]: I am always impressed by those figures, by the number of pounds per acre. I think it is very good for commercial fishing, but I don't think, to me, it gives the right answer to the fishermen.

In Canada we are used to determining the number of fish per hour. I would like to have your opinion on what it is by that standard.

MR. BYRD: Based on spot checks throughout the season, the average number of hours per fisherman trip was 3½ hours, so you can figure on that.

MR. SIEGLER [New Hampshire]: Does Alabama have a size limit on bass?

MR. BYRD: We do not have a size limit on bass, bluegill, redear sunfish or any other fish in Alabama.

MR. S. H. LAMB [New Mexico]: What is your cost per surface acre on these lakes for construction?

MR. BYRD: $480 average on these 12, sir.

MR. LAMB: How high would you think you could afford to go?

MR. BYRD: I think you could afford to go considerably higher. It is according to how much value you place on getting fishing for the fishermen. I think you could double it or triple it, if you could manage it so you could get so much fishing per acre.

MR. LAMB: What is a man's day of fishing worth?

MR. BYRD: That is a good question.

CHAIRMAN PAUL: That is a good question. I would like to hear an answer.

MR. LAMB: We have a problem of trying to beat down costs of construction of a 60-acre lake of $500,000.

CHAIRMAN PAUL: As an old engineer, I would say that might be high.

MR. STROUD: I wonder if these Crossley figures have any pertinence at this point. What do you think? You may know that back in 1956 the Fish and Wildlife Service sponsored a fishing and hunting survey that was done by

Crossley in New York. They came up with a figure of $4.80 as being the average expenditures by fishermen for fishing. That includes all those who travel great distances and so forth in fresh water; where perhaps it is a local trip, and overnight expenditures are not involved, such as the Alabama group might expect.

Our guess is that it would be roughly $3 a day. Another thing out in California, in connection with the river studies, they suggested a new approach of evaluating the intangible aspect of fishing. They suggest that the intangible aspects alone are worth $2 a day. I am not qualified to comment on the validity of that approach. It will be controversial for some time, but that gives you some range.

MR. BOB JENKINS [Sport Fishing Institute]: I would like to ask Mr. Byrd what he thinks the harvest and use might be in similar impoundments that weren't managed in Alabama.

MR. BYRD: I would estimate that it would probably be about 1/4 to 1/5 production in fishing. That is an estimation. I have no accurate figures to back that up.

FARMING FOR WATERFOWL IN THE PACIFIC FLYWAY

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There has been a significant trend in the development and management of private lands for waterfowl use in the Pacific Flyway during the past three years. At the current rate of expansion of this type of land use, a substantial improvement in waterfowl wintering habitat in the far-western states can be expected. Also important, improved facilities are being provided for waterfowl harvest to meet the demand of an increasing number of hunters.

The program of private land development and management described in this paper is primarily concerned with the production of waterfowl food by farming methods. Hence, the title "Farming for Waterfowl in the Pacific Flyway." Consideration is also given to food production by manipulation of ecological conditions on non-tillable lands.

Two types of private land ownership are generally involved in the waterfowl developments. The first type includes the privately owned or leased lands of the organized duck clubs. There are more than eight hundred such clubs controlling two-hundred thousand acres of land in the State of California alone. These lands are operated primarily for waterfowl shooting. In some instances, livestock production or another agricultural enterprise is a secondary land use.

The second type of ownership involves farmers who develop certain of their lands for waterfowl either for their own personal use or as a secondary farm enterprise. In the latter instance, only the shooting privileges are leased on the lands developed for waterfowl. These lands are generally marginal as far as other agricultural uses are concerned. It is not uncommon, however, for farmers to develop their more productive lands for waterfowl.

No estimate can be made of the number of individual units or total acreage of private land that may eventually be developed or improved for waterfowl in the Pacific Flyway. Up to the present time, the work has been centered in two areas: the Mojave Desert in California and the Willamette Valley-Lower Columbia River area of Oregon. In 1957 and 1958, the Soil Conservation Service, through soil conservation districts in California and Oregon, gave technical, on-site assistance to 65 individual farmers and 12 duck clubs. At the completion of the two year's work, 5,100 acres of land had been re-designed or developed and managed for waterfowl. It is important to note that the initial interest in the land treatment and management program resulted from one pilot development established in each of the two states in 1956 and 1957. Seven similar pilot projects are scheduled in 1959 by the Service in Utah, Idaho, Arizona and at a second location in California.

''Farming for waterfowl'' is a term conveniently used to describe the development and management of tillable lands for waterfowl. It is a term that is particularly useful in working with the duck club owners who are generally inexperienced in agriculture. Farming for waterfowl implies that modern farming technologies are employed in the annual production of a dependable, high-quality food crop for waterfowl. As this system is understood by the landowners, it is replacing the hit-or-miss methods of food plant selection and establishment that have usually resulted in failure. The waterfowl food crop on any ''farmed'' acreage can now be predicted in terms of pounds of food or numbers of duck-days feeding per acre.

Farming for waterfowl is not entirely new to agriculture. The agricultural techniques of this types of farming have been in common use on the Federal and State refuges or management units in the Pacific Flyway for a dozen or more years. Essentially the same techniques are the ones now being applied to private lands. The program involves site selection and preparation, the selection of adapted plant materials, seedbed preparation, proper seeding methods, fertilization, irrigation and crop management.

The areas developed for waterfowl farming involve a system of individual units. The units, in irrigated areas, are generally separated by dikes or ''checks' laid out on contours established at two-tenths of a foot vertical interval. Other units are established as level, irregular-shaped diked basins. Either system allows uniform irrigation of the food crop during the growing season. In non-irrigated areas, a less-uniform topography is usually found within the diked basins.

Waterfowl food plants are seeded on well-prepared seedbeds. The seeded areas are fertilized. Irrigation may or may not be necessary, depending on climatic and soil moisture circumstances. The seeding date is timed to permit complete maturity of the plants as close to the period of fall waterfowl migration flights as possible. This procedure is followed to avoid any lengthy period of depredation by non-game species.

Two plants established for standard use in soil conservation district cooperative waterfowl farming projects on marginal lands are:

Barnyard grass (*Echinochloa crusgalli* and varieties) and common sudangrass (*Sorghum vulgare sudanense*). Field corn (*Zea mays*) is also commonly used on higher capability lands within its growth range. Yields of 1750 pounds of seed per acre of barnyard grass (1500 pounds of *E. crusgalli* var. *frumentacea*) have been obtained on the alkaline, non-agricultural soils of the Mojave Desert. Sudangrass has produced 1500 pounds of seed per acre on poorly-drained Willamette Valley soils. On the basis of a 4- to 6-ounce daily food requirement for a duck, Oregon and California private land waterfowl farming projects are annually providing from 4,500 to 6,500 duck days feeding per acre.

Fall and winter flooding of waterfowl fields is accomplished by pumping, stream diversion or seasonal rains. The field dikes are designed to accommodate from two to sixteen inches of water. Drains are provided for each diked unit to permit complete water removal following waterfowl use. The proper tillage of the land can thus be accomplished, and cattails and other undesirable plants are discouraged.

A second type of waterfowl area development is concerned with marshlands. Marsh areas occasionally occur naturally or are artificially developed in connection with an individual waterfowl farming project. Other private land projects may involve only the improvement of natural marshlands for waterfowl.

The Fish and Wildlife Service has classified over 600,000 acres of land in the Pacific Flyway as fresh, saline or salt marsh. Much of this land is in private ownership. The Fish and Wildlife Service and state game management agencies have made good progress in the development of management programs for marshlands under their jurisdiction. Most of the techniques developed by these agencies are being adapted for use on private marsh areas in soil conservation districts.

An analysis has been made of economic data obtained from private land development for waterfowl projects on the Pacific Coast. These data indicate that lands of marginal agricultural value can profitably be used for waterfowl as a part of the farming or ranching enterprise. To illustrate this point, the development and maintenance costs of three farmer-developed waterfowl projects in the Central Valley of California were averaged as follows:

INITIAL DEVELOPMENT COSTS

Item	Cost per acre
Land leveling	$50.00
Levees, dikes and ditches	6.00
Fences	10.00
Buildings	6.20
Pipe and control structures	6.00
Blinds—1 per 5 acres @ $35.00	7.00
Farm truck—6 miles @ $.12	.72
Soil leaching—water cost and labor	3.00
Industrial insurance	.38
Plowing	6.00
	95.30

FIXED ANNUAL MAINTENANCE COSTS

Item	Cost per acre
Discing	$ 4.00
Harrowing and packing	2.00
Drilling	1.25
Seed	3.00
Maintenance	
Fences	.10
Buildings	.08
Levees and ditches	.35
Irrigation—three inches, six times per season	3.30
Fall flooding	2.30
Industrial insurance	.20
Farm truck—4 miles @ $.12	.48
Fertilizer—200 lbs. 21-0-0	8.00
Taxes	2.15
	27.21

The initial development cost of $95.00 amortized at 5% over a 15-year period places this cost at about $9.00 per acre annually. This cost added to the annual expense of maintenance gives a total operation cost of $36.00 per acre. Any profit from hunting begins at this point. From studies made of hunting lease rates in California, it is reasonable to assume that lands farmed for waterfowl would lease for $75.00 to $100.00 per acre annually. At these rates, the annual per acre net return to the landowner would be $39.00 to $64.00.

Many of the recent waterfowl farming projects on non-club, private lands have been made under the Conservation Reserve Program (Soil Bank Act of 1956). The Federal cost-sharing features of this program have reduced the landowner's initial cost of development by as much as 80%. In California counties, annual payments for land retirement from strictly agricultural use vary from $11.00 to $22.00 per acre during the five-year contract period. This payment also varies between states.

Conservation Reserve wildlife work in the Pacific Flyway has been concentrated in California and Oregon during the first two years of the program. In 1957, 106 acres were placed under Conservation Reserve contract for waterfowl development in California. This acreage was increased to a total of 388 acres in 1958. In a six-county area of the Willamette Valley in Oregon, twenty farmers developed over 500 acres for waterfowl and other wildlife under the 1957 Conservation Reserve Program. A substantial increase in both numbers of participating farmers and contracted acreage was made in 1958.

A unique feature of the Conservation Reserve Program provides that wildlife may be the only harvestable crop that can be taken from lands under contract. Thus, under certain hunting lease agreements, farming for waterfowl under the Conservation Reserve Program can become a profitable farm enterprise.

Farming for waterfowl in areas of alkaline soils is also being carried out as a temporary land use program. This is done during the years of land conditioning before profitable cropping can be put into effect. The salts must be leached from the soils by a flushing process before such soils can be cropped to cotton, hay or other field crops. The soil leaching program involves the impoundment of fresh water over the land surface for several months each year for a period of two or more years. The leaching process is facilitated by the use of salt-tolerant plants such as barnyard grass or barley. Where these plants are used, excellent waterfowl feeding or harvest areas are created. The temporarily idle lands are put to a profitable use by the farmer when shooting privileges are leased.

The development of plant materials for use in the program is one of the most important phases of land management for waterfowl. A working agreement was arranged in 1958 between the California Fish and Game Department, the California State Division of Soil Conservation and the Soil Conservation Service Plant Materials Center at Pleasanton, California, to undertake an orderly process of observing and testing promising plants under nursery and actual field conditions.

Several hundred plants, of known value in the production of waterfowl food, will be screened and handled in the course of this work. Performance of the plants, under various site conditions in relation to their intended use, is being evaluated. Propagation, establishment and cultural requirements are being established as the project is moved forward. It may be anticipated that superior waterfowl food plants will be put into standard use in the Pacific Flyway farming for waterfowl project.

It would be difficult to make an accurate prediction of the ultimate effect upon waterfowl of the habitat improvement work on private lands. As the application of the program is accelerated, however, there is no reason to believe that the benefits to the waterfowl resource will not entirely compensate for habitat destroyed or adversely modified by agricultural or industrial development in the Pacific Flyway.

DISCUSSION

DISCUSSION LEADER MENDALL: Thank you, Mr. Scheffer, for a very stimulating paper. Hearing something like that does most of us duck hunters and duck lovers a lot of good. We hear too much today about projects that ought to be done and work that should be started. Here we have an excellent example of something that needed to be done and was done, and was done successfully.

MR. LARRY JAHN [Wisconsin]: Am I to believe that you can take desert-type habitat under the conservation reserve and carry out this development and have payment offered to the land owner?

MR. SCHEFFER: I didn't mean to give that impression. Land must have a cropping history to be eligible for conservation reserve contract. The work in California that you saw illustrated by the slides was not done under the conservation reserve. Much of the land developed for waterfowl in Oregon, however, was formerly used for the production of agricultural crops. Most of the waterfowl developments on these lands were made under conservation reserve contract.

MR. A. WAGNER [New York State Conservation Department]: Under the CR program, would the contracts prevent the land owner from commercializing on this particular area that he receives public payments on. Can he rent this land out to individuals or clubs?

MR. SCHEFFER: The answer is no, he cannot lease his land. He can, however, lease his shooting privileges.

The law does not allow commercialization of conservation reserve developments. However, at least in the western states, the Department of Agriculture agency that is administering that program feels that if a land owner leases shooting rights to a group of individuals, that is not commercialization; but if he advertises in the paper to come out and hunt ducks and puts up blinds and buildings, that is commercialization. So far no one has gotten in trouble on that.

MR. E. BRYANT [Florida]: I presume in that desert country your big limiting factor in development is water. If you can develop that as so demonstrated for waterfowl, why can't other people come in there and develop it for agriculture? I am trying to get at the conflict of land uses.

MR. SCHEFFER: Not too far from the desert waterfowl development sites that were illustrated, land is in agricultural use. The principal crop is alfalfa hay. Some cotton and other crops are also grown. As I pointed out, there are about 25,000 acres of land in that soil conservation district that are unsuited for agricultural use because of adverse soil conditions. The problem in this particular instance involves shallow, alkaline soils. The common agricultural crops cannot profitably be grown under these conditions. Certain waterfowl food plants are well-adapted to these sites, however. There is no conflict in land uses.

QUESTION: In the case of land that is not suited for agricultural development in California, how are the water rights handled? Is that water pumped? How did they get the right to use water on land that is classified as not suitable for agriculture?

MR. SCHEFFER: The water is pumped. However, in this program, the farmer makes a decision as to how he will use the land and use the water. Some developments have gone in where water has come in through an irrigation district, and the owner has the water right. He decides whether he wants to use it for ducks or to raise cotton or alfalfa or whatever it might be.

CHAIRMAN PAUL: Do you know how much the farmer is able to lease that Antelope Valley land for, for shooting? That might be of interest to some of those people.

MR. SCHEFFER: In the Antelope Valley, Bob, there is no land leased. There are ten or twelve developments down there that are entirely operated by duck club type of groups. The price of land, since the initial developments were started, has gone up pretty high. That desert land used to be pretty cheap, but 130 acres covered with alkali as white as this sheet of paper went for $130,000.

MR. DILLON [Texas]: I have been working with a similar project and the monetary returns per acre have run anywhere from $20 an acre up to about $150 an acre on this type of development, above the cost of the seed. Of course, where we have rice farming and have the levees and water already there, we don't have those things to do. We are getting tremendous lease values in high population areas, such as in the area around Houston and New Orleans and across the Gulf Coast. It is getting to be something that is competing with cattle and rice and other agricultural crops in agriculture. I am thinking of this as an agricultural crop. Duck shooting can be just as profitable an agricultural venture as raising cattle or rice.

MR. SCHEFFER: That is an excellent point. The amount of money the owner might get would also depend on the pressure; of how close he was to Los Angeles or Portland or San Francisco or other large city.

MR. BROOKS [Alaska]: The term "agricultural crop" has been used in drawing the comparison in this matter, and I wonder if you are actually producing anything? Are you producing any ducks, or is this another way of harvesting or perhaps exploiting?

MR. SCHEFFER: The term "agricultural crop" implies that a crop is produced on the land. In the waterfowl work described, only duck food is produced at the development site. Certainly a duck better fed in the winter time, however, is going to return to the breeding grounds in a better condition. Perhaps in this way, the program does produce more ducks.

MR. BROOKS: It appears to me that if this is a commercial enterprise, that the ducks aren't going to be given too much of a break. As many hunters as possible will be accommodated on these areas, and the primary purpose is to take ducks off the land. It is a land usage, mind you, but it strikes me that the purpose is to take ducks, not produce ducks.

You are putting them in the bag, but not creating anything.

MR. SCHEFFER: I think that I see your point. There were very few ducks actually produced in that country even before the developments. Most of the private waterfowl developments that have been made in California were made on lands that have been in duck club use for many years. The trend is toward the improvement of additional lands of this type for shooting. There is a tremendous competition between the clubs for ducks now. As competition grows, more lands will be improved and the waterfowl flights will be spread over more acreage as they were years ago when these lands were first flooded for ducks. The production of food on these same lands for the attraction of ducks does not seem to be an exploitation of the waterfowl resource.

MR. PAINTER [Canada]: I am from Regina, Saskatchewan. I look on this business the same as my friend from Alaska. You know, in our province it is against the law to take land for shooting rights. This is an international bird we have got, and it looks to me as if we are trying to handle them entirely different on each side of the boundary. Maybe we had better wake up there. We are not going to continue to send you more ducks to sell.

MR. SCHEFFER: The point should be made that the Soil Conservation Service is not promoting commercialization of wildlife. The farmer or land owner makes a decision, and technical help is being given, but we are not promoting commercialization.

CHAIRMAN PAUL: Apropos of that last discussion, I can't help but make one remark. I am originally from California. To assuage the fears of our friends across the border, the actual amount of duck habitat in California has decreased at a tremendously rapid rate. I would estimate about one million acres has gone out of duck production into farms, and I think the Department of Fish and Game feels that the development of additional area is very critically needed in California. Certainly enough money has been spent on it. I think this emphasis on the private land developing of good holding grounds for wintering population of the flyway is still a very important factor. It probably overcompensates or outweighs any commercialization that might result from additional shooting pressure.

CONTROLLED GOOSE SHOOTING AT MICHIGAN'S SWAN CREEK HIGHBANKS

CHARLES E. FRILEY, JR.[2]

Michigan Department of Conservation, Allegan, Michigan

The Swan Creek "Highbanks" is one of the most popular locations in Michigan for hunting the Canada goose *(Branta canadensis)*. The Highbanks is part of the Swan Creek Wildlife Experiment Station of the Game Division of the Michigan Department of Conservation. The station is first of all a place for research on wildlife problems, and secondarily, a 7,000-acre area open to managed public hunting.

This paper discusses development of our hunter control system and the harvest, hunting success, and hunting pressure from 1953 through 1957. Finally, it presents suggestions for extending managed hunting in the Swan Creek area.

THE AREA

The Highbanks is a level, wooded area lying above and beyond a 90-foot escarpment rising from a floodplain west of the Kalamazoo River, in west-central Allegan County (Fig. 1). It is 9 miles northwest of Allegan and 31 miles southwest of Grand Rapids, almost in the center of the Allegan State Forest. The vegetation on the Highbanks consists largely of oak with scattered white pine. The floodplain below is now artificially flooded and contains three cover types: (1) a dead and dying forest of the black ash-American elm-red maple forest type, (2) a true marsh on formerly farmed land, and (3) more recently, swamp thickets of young willow, maple, and alder. The entire impoundment is called the Farm Marsh. Chemical and mechanical control operations under way since 1954 are eliminating this nuisance shrubby vegetation and opening up the marsh again.

The Farm Marsh, along with the Ottawa Marsh and the Koopman Marsh on the experiment station, attracts large numbers of waterfowl each fall. Springs on the west side of the marsh, together with annual precipitation, feed this 540-acre impoundment, which the Kalamazoo River inundates during severe floods. The marsh is a waterfowl refuge and closed to the public from September 15 to December 15 each year, but is open to fishing at other times.

The Highbanks goose shooting area is a mile long, a quarter-mile deep on the north, and a mile deep on the south. The area from which

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[1]A contribution from Federal Aid Project W-89-R, Game Division, Michigan Department of Conservation. C. H. Douville and H. L. Wilson were leaders during the period of this study. The staff of the Swan Creek Wildlife Experiment Station collected the data.

[2]In the absence of the author, this paper was read by S. C. Whitlock.

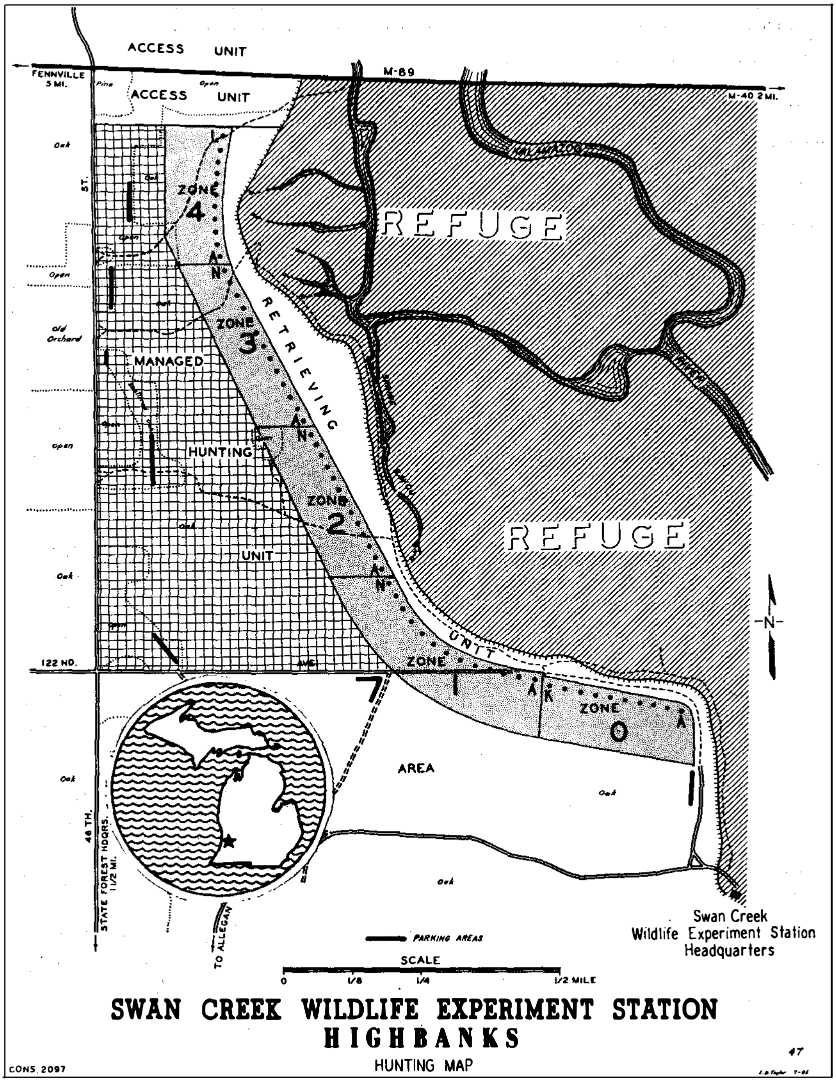

Figure 1. Hunting map of the Swan Creek Highbanks, 1957

hunters shoot is an oak forest of medium stocking, up to 12 inches d.b.h., with a few open fields.

Western Allegan County is the biggest goose concentration area in Michigan because of the close proximity of excellent feeding grounds and resting areas. The Fennville State Game Area, 8 miles west of the Highbanks, is by far the most important feeding area. The Ottawa Marsh, 3 miles northwest of the Highbanks, and the Farm Marsh, constitute the principal resting areas. Daily movements of geese out of the Farm Marsh to the corn and grain fields on the refuge at the game area provide shooting opportunities for the Highbanks hunters.

HUNTER CONTROL

Only the most general type of control over hunters was necessary from 1939 through 1949. The sole function of annual permits issued during this period was to provide a measure of the game harvested by hunters, hunting pressure, and perhaps game populations on the experiment station. The permits were valid for the full hunting season on the entire station, except on refuges and special study areas. Each hunter reported his kill of game at the end of the season. In the early years of this period, especially, waterfowl was an incidental part of the game bag.

Creation of the Farm Marsh in 1943 changed the picture. Use of this area by geese and the adjacent Highbanks by hunters soon produced conditions highly hazardous to the hunters. The need for some type of hunter control at the Highbanks became apparent in 1949 when as many as 600 hunters lined the top of the escarpment in one day. In 1950, therefore, a system of daily permits for hunting was initiated. Permits were issued "first come, first served" for four 40-permit numbered zones, constituting the Restricted Waterfowl Hunting Units. In 1952 when State Highway M-89 was completed across the north end of the Farm Marsh, Zone 4 was reduced to half its former capacity by the establishment of the Access Unit, which was closed to shooting to protect motorists on the highway.

Also in 1952, the daily permit system was extended to the area immediately behind the four zones. This area, called the Managed Hunting Unit, served as an unlimited-capacity overflow area. To try to establish some kind of order in the waiting line, we hung metal discs with numbers in sequence on a wire outside the headquarters office door. As hunters arrived at the headquarters during the night, each picked up a number to establish his priority to receive a permit. This continued through the 1953 season, but proved inadequate when local hunters came early in the evening and procured handfuls of the discs for friends in town. The intended "first come, first served" system broke down.

In 1954, we added Zone "O" along the southeast part of the Highbanks in what had been part of the seasonal permit area, and distributed the 140 permits over five rather than four zones. This eased somewhat the crowding in the larger zones. Closing time for Highbanks shooting was set at 12 noon to encourage the geese to return to the Farm Marsh in the afternoon more readily. Hunters could wait in their cars in a first come, first served order. Issuing of numbered registration cards to car occupants shortly before the office opened was an improvement over the former system. However, it deteriorated when late-comers began joining their friends near the head of the parking line. We found it necessary to make evening car checks to spot unoccupied cars and to determine the actual order of arrival of individuals. When it was apparent that we meant to enforce the first come, first served system in an orderly manner, hunters made up their minds to earn positions rather than "chisel" for them. They make very few deliberate attempts to "beat" the system now because, as a group, they do a pretty fair job of policing themselves and seeing that others follow the regulations.

Following the 1954 season, we received a complaint that too many people were hunting too many times and were thereby keeping others from an opportunity to hunt. In 1954 a total of 135 individuals hunted more than 6 times during the season. To spread hunting opportunities over a larger number of hunters, in 1955 we established "preference permits" and limited each hunter to 3 such permits. A priority permit was one issued in the morning before shooting started, valid in one of the zones. Permits issued after the opening hour or for the overflow area behind the zones did not count against the hunter. This device succeeded in spreading the preferred hunting opportunities among more people. We continued the evening car checks and issuing prenumbered registration cards to car occupants before the office opened, and it worked well.

Starting in 1956 we issued permits for specific posts rather than zones, 2 or 3 hunters to a post, still on a first come, first served basis. The 60 posts accommodated from 120 to 180 permittees at one time. There was still no limit on permits in the Managed Hunting Unit behind the zones. Closing time was shifted to 3:00 p.m. throughout the season.

The 1957 season saw no changes on the Highbanks and only one at the Headquarters. For more orderly parking, we erected wire barriers with numbered parking positions on the parking lot. First arrivals parked at the lowest available numbers, remained with their cars on the lot, and received their prenumbered registration cards early the following morning. Everyone knew where he stood when he arrived at the parking position.

We think, now, that we have the first come, first served system pretty well worked out. The addition of more zones or the conversion of part of the Managed Hunting Unit to zones should alter procedures very little, if any. Some of us, hunters and conservation officials alike, are not completely satisfied with the system. Waiting for permits and crowded conditions in the hunting zones are not in keeping with our concept of waterfowl hunting.

During the 1957 season, with 3,300 more permittees than ever before, we had no complaints about our system of priorities. We did have some disappointed people, especially those from out of state or from distant points in Michigan. When we talked with some of them, their usual reaction was, "We'll come earlier next time." None offered suggestions for a system they believed more workable or fairer to all hunters. Very few objected to the regimentation we feel is necessary for protection and efficient handling of the crowds of hunters who use the Highbanks. As long as all were treated alike, no one felt unduly abused.

Parking has become a primary problem at our headquarters. At least 10 times during the 1957 season, parking for Saturday or Sunday hunting was well under way by noon the previous day. On one occasion, a group of hunters was waiting on Saturday morning for the Saturday hunters to leave for the Highbanks so that they could park for Sunday hunting, 24 hours away. Restrictions on such activity would probably only create a jam somewhere else that might be much worse than at the headquarters where we can control traffic. Mostly, the situation is about as amusing as it is troublesome, and it provides plenty of food for chatter on the parking lot throughout the day and evening. Our current procedures at the headquarters and on the Highbanks are set down in detail in Figure 2.

GOOSE HARVEST AND HUNTER SUCCESS

Since 1950, when the issuing of daily permits began, the station staff has examined all geese bagged at the Highbanks. Reports filed by the hunters after each hunt gave a careful measure of hunting pressure and hunting success. I am publishing elsewhere data on sex, age, and weights and related items.

During the 5 years from 1953 through 1957, Michigan's waterfowl seasons opened on October 1. Closing date was November 24 the first 2 years, December 9 the last 3 years.

The five-year harvest of the 6,618 large Canada geese shot at the Highbanks made up over 99 per cent of the goose bag. Hunters shot from 4 to 10 Hutchins' geese *(B. c. hutchinsii)* in 1955, 1956, and 1957, from 1 to 6 blue geese (*Chen caerulescens*) each year through 1956, and 1 snow goose *(Chen hyperborea)* in 1954. The low bag of 695 Canada geese occurred in 1953; the high kill of 1,659 took place

SWAN CREEK HIGHBANKS
PERMIT PROCEDURE
FOR 1957

The operation of the Highbanks (Restricted Waterfowl Hunting Units and Managed Hunting Unit) at the Swan Creek Wildlife Experiment Station will be governed by the Rules and Regulations for the Experiment Station as ordered by the Conservation Commission and by the following details of procedure on the area.

(1) *Daily permit* must be secured at the Swan Creek Experiment Station office for each hunt at the Highbanks. You do not need a seasonal permit (for hunting on other parts of the station) in order to get a daily permit.

(2) Daily permits are limited in number in the zones. Permits are issued on a first come, first served basis. Priority for permit issuance is based solely on the "first hunter come, first hunter served" principle. Hunters arriving early in groups of two or more, and *remaining in their positions,* have priority over those *arriving* at the parking lot later. Single hunters must team up with another single or pair of hunters. Hunters leaving the headquarters area forfeit their priority upon departure.

(3) Applicants for permits must park their vehicles in order of arrival at the lot. First vehicle takes position No. 1; second vehicle, position No. 2; etc. For location of parking positions see chart on bulletin board.

(4) *Tents may not* be used in the headquarters area and sleeping on the ground will not be permitted (safety measure). Vehicles or vehicle combinations *exceeding 20 feet may not* be parked on the waiting lot. (Space considerations.)

(5) Numbered registration cards will be handed to applicants *in their vehicles* a few minutes before registration begins (about 5:30) each morning. The numbered cards will be distributed in order and will show the order in which applicants are admitted to the headquarters building to receive permits. Hunters may choose hunting positions. The permit is authority for occupancy of the position.

(6) Hunters should take position in line *at the office* door only after receiving registration cards. Pencils are available in the office. Hunters arriving too late to be issued registration cards on the parking lot will be issued cards and permits after those with cards have received permits.

(7) Of those hunters seeking permits before legal shooting time after October 20, *preference* will be given to *those who have not hunted three times* in restricted hunting zones under a *preference* permit. After that time (½ hour before sunrise) no preference will be given, but priority will be maintained. Preference permits issued for Zones 0, 1, 2, 3 and 4 will be recorded by punching hunters' small game licenses. Any permit issued to a restricted waterfowl hunting zone before shooting time is a *preference* permit. Managed Hunting Unit permits are never *preference* permits.

(8) All Highbanks hunters must show their small game license and migratory bird hunting stamp during registration. *These are not for sale at the station.*

(9) Restricted (Zone) permits *will be reissued* as they are returned to the headquarters.

(10) All Highbanks hunting must stop by 3:00 p.m. and outstanding permits returned immediately.

(11) Permits will be issued to a party of 2 or 3 hunters for a specific shooting post within the zones. Hunters must obtain and return permits together. Zone 0 has 10 posts; Zones 1, 2, and 3 each have 13 posts; and Zone 4 has 11 posts. There are no posts in the Managed Hunting Unit and no limit to the number of permits issued to that unit. Permits will be issued daily beginning at about 5:30 a.m.

(12) All game shot on the Highbanks must be submitted for examination at the headquarters. Do not leave the experiment station before you have returned your permit to the headquarters.

(13) Do not shoot from a position more than 30 feet from your assigned post. Dogs and game calls are prohibited.

Figure 2. Swan Creek Highbanks permit procedure for 1957.

the following year. The harvests in 1955 and 1957 were over 1,600 (Table 1).

TABLE 1. SWAN CREEK HIGHBANKS HUNTING DATA (1953-1957).

Year	Canada Geese	Ducks	Permits issued	Hours hunted	Shells fired	Permits per goose	Hunter hours per permit	Hunter hours per goose	Shells per permit	Shells per goose	Total weight (tons)
1953	695	6	8,472	25,418	58,107	12.2	3.0	37	6.9	84	2.7
1954	1,659	22	9,074	29,983	87,133	5.5	3.3	18	9.6	52	6.6
1955	1,610	22	10,627	32,597	112,269	6.6	3.0	20	10.6	70	6.5
1956	1,025	80	10,706	38,998	71,460	10.4	3.6	38	6.7	70	4.1
1957	1,629	178	14,004	53,787	117,949	8.6	3.8	33	8.4	72	6.5
Total	6,618	308	52,883	180,783	446,918	....	....	....	....	....	26.4
Ave.	1,324	62	10,577	36,157	89,382	8.9	3.4	27	8.5	68	5.3

Regulations require Highbanks hunters to return their daily permits to the headquarters in person and submit their game for an examination, which includes identification, sexing, aging, weighing, and inspecting for bands. These data are recorded on the hunter's registration card. At the same time we ask each hunter how many shots he fired, and how long he hunted (Table 1).

In this paper I analyzed and compared the annual harvest and hunter success data through four calendar periods based on hunter interest. During the first period, October 1 to 20, the waterfowl season alone holds the interest of active gun hunters. (In 1957, when the first day of small-game season was changed to avoid a Sunday opening, the first period ended on October 21.) The second period, October 21 to November 14, extends from the opening day of small-game season to the opening day of the firearm deer season. The third period, November 15 to 24, ends on the last day of the 1953 and 1954 waterfowl seasons; it includes the first 10 days of the 16-day deer season. The final period, November 24 through December 9, completed the season in 1955, 1956, and 1957.

According to the average daily bag of Canada geese at the Highbanks (Table 2), the most successful of these hunting periods in four out of five years was October 21 to November 14. In 1956 the late November period was best. In each year the second most successful period followed the best one. The early October period consistently provided the poorest success. The best season was 1954; the poorest 1953.

A somewhat erroneous impression still exists among the hunters re-

TABLE 2. AVERAGE DAILY CANADA GOOSE KILL AT THE HIGHBANKS (1933-1957)

Year	Oct. 2-19	Oct. 21-Nov. 14	Nov. 15-24	Nov. 25-Dec.9	Entire Season
1953	5	20	12	....	13
1954	13	42	39	....	31
1955	4	42	28	7	23
1956[1]	3	9	36	25	15
1957[2]	9	37	32	16	24

[1]First period in 1956 and 1957 included October 1.
[2]First period included October 20. Second period began October 22. No Highbanks hunting on the opening day of small game season from 1953 through 1957.

garding the best days to hunt on the Highbanks. Days with low clouds and temperatures 10 to 20 degrees above freezing seem to bring out more hunters. Frequently such days were no better than the bright sunny morning before or following. The arrival of newcomers from the north results in increased kills. Of perhaps greater influence on the harvest is the force and direction of the wind. A strong west wind, almost regardless of sky cover, enables the geese to attain altitudes safely beyond the range of all but the longest-range shotguns. The number and distribution of those hunters who try to stretch the range of their guns has a decided bearing on shooting success. I think there are at least three reasons for these sky shooters doing as they do. Many hunters are born optimists and hope that one of those long shots will somehow be a lucky one. Others either actually do not know the capabilities of their guns or do not realize that the object in their sights should appear two or three times larger than the duck or pheasant they last brought down. Still others feel that they must get the first shot at a flock. Regardless of why it is done, sky-shooting is one of the best ways to ruin a morning's hunting on the Highbanks for everyone.

As the season progresses, some geese seem to become aware that they can escape the guns altogether by swinging out of the marsh north of the usual route. The Access Unit bordering Highway M-89 (Fig. 1) is closed to hunting. This area connects with the refuge and many thousands of geese, presumably the "educated" ones, leave the refuge by way of the Access Unit and M-89 and thus escape the guns.

Finally, regardless of how many geese are in the marsh, if they do not come out over the Highbanks there is no shooting. With only 1,000 birds in the marsh throughout the early part of October, 1957, the harvest was much greater than in October, 1956, when nearly 2,000 geese were in the marsh. We do not know why the geese flew out each day in October, 1957, and did not in October, 1956. We thought food and water were more attractive in the marsh in 1957 than in 1956.

The goose harvest at the Highbanks is only a portion, from 40 to 70 per cent, of the total recorded harvest in the lower Kalamazoo River area below Allegan. Since 1954 this take has been between 2,400 and 4,200 geese each year (Table 3). Daily check-in and check-

TABLE 3. RECORDED GOOSE HARVEST ON STATE AREAS IN ALLEGAN COUNTY (1953-1957)

Area	1953	1954	1955	1956	1957
Swan Creek Wildlife Experiment Station					
Highbanks	701	1661	1625	1030	1637
Seasonal Permit Area	95	539	1159	732	943
Fennville State Game Area	156	584	1401	635	1187
Total geese	952	2784	4185	2397	3767

out of hunters at the Fennville State Game Area, just as at the Highbanks, provides an opportunity to count and examine all geese. In addition, on over 5,500 acres of the experiment station outside the Highbanks and the Swan Creek Marsh refuge hunting is allowed on seasonal permits which require an end-of-season report of hunting and harvest. The annual goose kill on this 5,500 acres, which includes the Ottawa Marsh and much of the Kalamazoo River for 6 miles downstream from the Farm Marsh, more closely approximates the size of the kill on the Fennville State Game Area than the take on the Highbanks. The record of the total harvest from seasonal permittees is incomplete, because some permit holders fail to report.

HUNTING PRESSURE

Hunting pressure at the Highbanks has increased in each succeeding year covered by this study. The same thing has been apparent at the other state waterfowl hunting areas in western Allegan County. I am sure we will see a continuing increase as long as we can provide a place to accommodate the increasing pressure. Because pressure is so great it is going to be a continuing necessity to restrict the number of hunters here and in other wildfowling areas in southern Michigan. Pressure is sure to continue to build up and available private lands will continue to decrease in coming years with the result that we will have to extend restrictions to cover state areas not now regulated. The state has been fortunate in being able to secure for public hunting such lands as the Swan Creek Highbanks, the Fennville State Game Area, the Ottawa Marsh, and other important areas below the Allegan Dam on the Kalamazoo River.

Recent consolidation of private holdings adjacent to the Swan Creek Wildlife Experiment Station has pointed up the value of public lands available to all who wish to hunt, and the necessity for the state to continue to procure for public use such lands as can be bought for a reasonable price. The public uses western Allegan County game lands more heavily for recreation than most other game lands in the state.

Since 1953 we have issued 52,883 hunting permits at the Highbanks. Hunting pressure at the Fennville State Game Area has been even heavier, and reported pressure in the Ottawa Marsh has been only slightly lighter than at the Highbanks. From 8,472 permits in 1953, pressure at the Highbanks increased to 14,004 in 1957, without any expansion of the area. Annual pressures have responded weakly to variations in hunter success, but not enough to prevent an increase in 1956. Early-season success in 1957 resulted in a 31 per cent increase in hunting pressure over 1956.

Average daily hunting pressure was greatest in 1957, with 203 permits per day throughout the season. It was next heaviest in 1954 with 171 permits per day (Table 4). These, with 1955, were the three most successful years. In 1955, however, when the number of times a hunter could secure a zone permit was limited, pressure dropped noticeably even in the face of higher success.

TABLE 4. ANNUAL AVERAGE NUMBER OF PERMITS ISSUED EACH DAY OF THE WEEK AT THE HIGHBANKS AND DAY MOST PERMITS WERE ISSUED (1953-1957)

Year	Sun.	Mon.	Tues.	Wed.	Thurs..	Fri.	Sat.	Average	Maximum	Date	Day
1953	266	128	117	137	137	101	221	160	426	Nov. 8	Sun.
1954	236	136	147	159	152	146	216	171	333	Nov. 14	Sun.
1955[1]	245	124	114	129	151	111	203	154	400	Nov. 6	Sun.
1956[1]	252	106	97	115	161	127	241	155	407	Nov. 22	Thu.
1957[2]	316	154	142	158	188	149	309	203	455	Nov. 9	Sat.
Ave.	264	129	123	138	160	126	240	169			

[1]Limit of three preferential permits per hunter for entire season.
[2]Limit of three preferential permits per hunter after Oct. 21.

In all years, the heaviest and next-heaviest days of Highbanks hunting pressure have been Sunday and Saturday, respectively. There was a differential between the seasonal averages for these two days of from 20 permits to 40 permits from 1953 to 1955. This differential decreased to 11 and 8 permits, in favor of Sunday in 1956 and 1957, respectively. Failure to get a good shooting position on one day encourages hunters to shift, when possible, to less crowded days. This, I think, is the main explanation for the declining differential between the two week-end days. Thursday and Wednesday have, with minor exceptions, been the week-days of heaviest hunting pressure. There is still less pressure on Monday and Friday. Least hunting pressure on the Highbanks is on Tuesday.

As each season progresses, hunting pressure responds to hunting success, with a time-lag factor influencing pressure later in the season. The word of success passes around quickly, but before some hunters can act on it, chances for success have often declined.

Hunting pressure by periods, year after year, is quite variable. Only one feature stands out—pressure is lowest during early October (Table 5). In 1953, pressure during the last two periods was nearly the same. Pressure increased from the second period to the third in 1954. In 1955 hunting pressure declined from the second through the third to the fourth period. Just the opposite was true in 1956. Pressure was reasonably consistent at a high level throughout the last three periods in 1957. Hunting pressure during the season, then, follows hunting success.

TABLE 5. AVERAGE NUMBER OF PERMITS ISSUED DAILY AT THE SWAN CREEK HIGHBANKS (1953-1957)

Year	Period	Zones only	Zones and managed unit
1953	October 2 - 19	82	98
	October 21 - November 14	146	192
	November 15 - 24	149	191
1954	October 2 - 19	96	130
	October 21 - November 14	143	188
	November 15 - 24	145	204
1955	October 1 - 19	66	72
	October 21 - November 14	139	217
	November 15 - 24	122	175
	November 25 - December 9	101	138
1956	October 1 - 19	66	75
	October 21 - November 14	106	135
	November 15 - 24	140	225
	November 25 - December 9	152	244
1957	October 1 - 20	96	136
	October 22 - November 14	144	234
	November 15 - 24	154	237
	November 25 - December 9	141	220

Note—No permits issued on October 1 in 1953 and 1954 or on the first day of the small game season in any year.

As an outgrowth of a complaint during the 1954 season, we checked to see how many times individual hunters hunted. We had not yet limited the number of permits per hunter in 1954. In that year 86 per cent of the individuals using the Highbanks hunted 1 to 3 times, 11 per cent hunted 4 to 6 times, 2 per cent hunted 7 to 9 times, and 1 per cent hunted 10 times or more (Table 6). In 1955, we imposed our limit of 3 preference permits per hunter as mentioned earlier. This change increased the percentage of persons hunting up to 3 times and reduced the number hunting 4 to 6 times, compared to 1954. The proportion hunting 6 times was cut almost in half. A slight increase among those hunting 4 to 9 times occurred in 1956 and a

TABLE 6. HIGHBANKS PERMITS ISSUED TO INDIVIDUAL HUNTERS

Number of permits	Actual hunters				Percentage of all hunters			
	1954	1955	1956	1957	1954	1955	1956	1957
1	2434	3484	3267	3769	54.7	60.0	59.8	55.0
2	974	1225	1125	1513	21.9	21.1	20.6	22.1
3	418	613	555	760	9.4	10.6	10.2	11.1
4	280	230	216	348	6.3	4.0	4.0	5.1
5	146	110	109	193	3.3	1.9	2.0	2.8
6	57	41	60	84	1.3	0.7	1.1	1.2
7	48	34	35	65	1.1	0.6	0.6	1.0
8	31	27	28	40	0.7	0.5	0.5	0.6
9	18	14	18	21	0.4	0.2	0.3	0.3
10	22	7	17	19	0.5	0.1	0.3	0.3
11	4	4	12	14	0.1	0.1	0.2	0.2
12	4	3	5	7	0.1	0.1	0.1	0.1
13	....	4	3	5	....	0.1	0.1	0.1
14	2	2	3	9	T	T	0.1	0.1
15	....	....	1	1	....	....	T	T
16+	6	5	6	11	0.1	0.1	0.1	0.2
Total	4444	5803	5460	6859				

much greater increase showed in 1957. This was possible because an individual was limited only as to the number of preference permits he could get. Permits issued after shooting time each day and to the Managed Hunting Unit were not limited to individuals. The average number of permits per individual was 2.04 in 1954, 1.83 in 1955, 1.96 in 1956, and 2.04 in 1957.

The reaction to this restriction in 1955 was very much less than expected. Practically all our hunters, when they realized that the supply of hunting spots was far below the demand, saw the necessity for passing around the better hunting opportunities. An ever-increasing, although still small, group of hunters return to the Highbanks to hunt in the Managed Hunting Unit after they exhaust their preference permit status. The sight of the geese and the opportunity to have a gun, a place to use it with permission, and an outside chance to bring down a "loner" or a "sneaker" induce many goose hunters to return to shoot behind the zones in the Highbanks Area.

MANAGEMENT SUGGESTIONS

Highbanks hunting has been handled on a free "first come, first served" basis for 8 years with virtually no increase in area to accommodate the constantly increasing hunter demand. If we are to fulfill our obligation of providing hunting opportunities for our expanding army of hunters, two phases of our operations must receive attention.

1. *Refuges:* We must establish additional refuges to attract geese in the fall and afford them protection during the hunting season. The refuges on the Farm Marsh and at the Fennville State Game Area

serve these functions well. Geese are able to depart and enter as they please. Hunters quickly depleted unprotected areas of both geese and ducks each morning. We should not, however, try to turn everything into Highbanks-type hunting. We should, on the other hand, endeavor to find ways to provide several different types of hunting. A square-mile refuge in the Ottawa Marsh should result in more hours of marsh shooting each day and more waterfowl in the marsh during the day. An alternative to a refuge would be an early afternoon closing hour to allow waterfowl to return unmolested. They would then be on hand for the following day's opening hours. A one-quarter to one-half square mile refuge in a state-owned impoundment near the southwest corner of the Allegan State Forest surrounded by both pass-shooting and jump-shooting areas would tend to further spread out the goose flock as well as the hunters. We can handle other areas similarly, as acquisition or development makes suitable habitat available.

2. *Registration of Hunters:* An impartially selected sample of Highbanks hunters in 1955 expressed an overwhelming desire to retain the first come, first served system rather than change to any of four systems suggested. Small segments, however, favored preregistration by mail and morning or evening drawing for posts. The overwhelming favor for the existing system may have been influenced by lack of familiarity with any other system. (Michigan's Conservation Department operates all its permit hunting areas on a first come, first served basis.) It is time-consuming for the hunter and often uncomfortable, but it seems to be the fairest system, requiring neither money nor chance—only the desire (and the time) to devote necessary time to earn the desired shooting position. Pre-registration by mail might be expensive and time-consuming for the Department and might subject us to accusations of favoritism. We could not afford to do it without charging a fee for the services, and we have no legal authorization for such fees at this time. Pre-registration would, however, enable successful applicants to plan with certainty for a hunt and would do away with the necessity of staying at the headquarters parking lot all night to hold a position for a permit the following morning.

Drawing for posts puts everyone on the same basis at the start of the drawing. The element of chance, of course, is high. Hunters who would go to nearly any necessary inconvenience or extent to get a Highbanks permit might, by the chance of the drawing, be denied front line shooting throughout an entire season. Under the current system the stronger the individual's desire to hunt, the greater the effort he will exert to be among the first to receive permits. I think it would be worthwhile to have a limited trial of one or both of these systems—say one day per week throughout a season—to see how each works out. For economy of operation, centralization of control, and a wider choice of locations for the hunter, we can issue permits from one centrally located checking station for the Highbanks, the Fennville State Game Area and any other areas in this vicinity that might be brought under the controlled hunting system.

We have endeavored at the Highbanks to accommodate as many hunters as possible consistent with gun safety. Since nearly all shooting is upward, the chances for injury are low. We have tried to avoid overcrowding, but at the same time we have sought to utilize the area to its fullest extent. These guides will serve us as long as we must retain our present system, to the end that the greatest number of hunters possible may enjoy, through seeing and shooting the waterfowl that use this area, a safe, orderly, and continuing hunt.

SUMMARY

Canada goose shooting at southwestern Michigan's publicly-owned Swan Creek "Highbanks" is available without charge on a "first come, first served," daily-permit basis. Geese fly from a 540-acre refuge marsh early each morning, from late September throughout the hunting season, over a wooded "Highbanks" to feed at the refuge on the Fennville State Game area, 8 miles to the west. Hunters on the Highbanks shoot at the birds as they fly over. From 1953 to 1957 nearly 53,000 daily permits were issued to an annually increasing group of hunters. They shot 6,618 of the large Canada geese, 22 Hutchins' geese, 13 blue geese, and 1 snow goose; hunted more than 180,000 hours; and fired nearly 450,000 shotgun shells. I have traced the evolution of the hunter control system and described current control procedures. Weekends and Thursdays were the days of heaviest hunting pressure. Between 55 and 60 per cent of the individual hunters secured only 1 permit per year, 20 per cent got 2 permits, 10 per cent got 3 permits, and 5 per cent got 4 permits.

DISCUSSION

DR. MENDALL: Thank you, Mr. Whitlock, for a very informative presentation. I thought in my travels around the country I knew a little something about crowded marshes and heavy hunting pressure, but I hadn't seen or heard anything until this afternoon. There are a number of details that are absolutely amazing.

It certainly should convince anyone that there is no conceivable limit to what a waterfowl hunter will do to kill a bird or to attempt to kill a bird. This certainly poses a problem for the State of Michigan. I am sure, however, that two organizations are extremely happy about this situation, and those are the Winchester and Remington people.

I would just like to ask one question, Mr. Whitlock. You mentioned that it took between 60 and 70 shots to bag a goose. I am wondering if you correlated that figure in any way with the number of bottles of beer that were consumed the night before.

MR. WHITLOCK: I am sure there is a direct correlation, but this is not a drunken orgy. The hunters really comport themselves very well. We have very little trouble with them, and it is a kind of carnival atmosphere in a way, and in other ways, it isn't.

Generally speaking we have a system now that works pretty well, and we will probably think quite a while before we change it. It is possible, as I said before, that there might be some preregistration.

We have thought about one day a week or two days a week to take care of hunters that don't want to endure the physical beating that some of them take in order to get a chance to hunt geese. That is a possibility.

Right away, though, you run into a lot of secretarial work, and then you may run into this other objection, the possibility that there is a suspicion by the hunters that they are getting short-changed. They know under this system that if they get there early enough, they are going to have their choice of the best place to hunt.

MR. JOHN GOTTSCHALK [Washington]: Would you care to tell us what the cost is per goose to develop an area like this or what the cost is per hunter?

MR. WHITLOCK: I simply can't tell you. As far as development here, it really didn't cost much. This was a sort of ready-made affair. This place did exist as a river-bottom farm. When we purchased the place, the dikes were already in, and there was quite a bit of water already there, and geese were using it. We have improved it somewhat.

Fortunately the highway put through a new road, and we were able to use their road grade as a part of a dam, a water control structure, so that it cost a lot less than if we had started from scratch.

Actually the big costs are administrative costs, and the physical layout is relatively inexpensive. Nature put it there. Of course, this other area, which is an integral part of the project, some six or seven miles away, cost us about $125,000. With that setup then, we had to go through farming operations, some by share cropping and some that we carry on ourselves. Goose hunting is expensive any way you look at it, it seems to us, but I can't give you a breakdown in dollars and cents as to just what it cost the state or the hunters of Michigan to bag a goose. It must be high.

MR. JAHN [Wisconsin]: First, is there a fee charged of the people that use the area?

MR. WHITLOCK: No, we don't charge a fee, and we know that in some states they do. Really I feel there should be a fee charged because they are getting a lot of service there, and it is discrimination in a sense between types of hunters, as a deer hunter or cotton-tail hunter or a goose hunter. I really think there ought to be a fee, but we haven't charged any yet.

MR. YOUNG: An unwritten policy in our state has been to charge a fee on our goose hunting areas, so that the services performed for the people are paid by the people actually getting the services. This then leaves your general funds available for the purchase of more lands.

The other question I had for you is, do you have any idea of what your crippling losses are under these types of conditions, where you are trying to bag birds at a high altitude?

MR. WHITLOCK: No. Most of the birds that fly out go to the other area, which is six or seven miles away. We can't really tell you what the crippling loss is. Any goose, of course, that flies low and isn't able to get out of that zone of fire, isn't crippled very long because somebody picks him up. He has to fly over a strip a half mile wide before he is anywhere near safe.

I would suspect that it is just like it is in the case of other waterfowl. It probably runs 25 or 30 per cent. If they go over to the other area, and are flying low, when they get there, they are no longer crippled. Somebody picks them up.

MR. JAHN: From my experience in the State of Wisconsin under various habitats, I would guess your crippling loss must be relatively high. Too, if this assumption is correct, have you ever considered moving your shooting zone to your crop field where you would have your birds in much closer range?

MR. WHITLOCK: We do have a shooting zone around the cropped area as well. That is another setup that we call Fennville State Game area. It is really a part of this one but is administered differently.

Hunting success there is similar to what it is here, although it is a different type of hunting. They have a chance to use blinds and decoys there, which they don't have here. This is strictly pass shooting, and real high pass shooting.

MR. JAHN: Based on our experience, in the use of a first-come, first-serve system for a number of years, we found that actually we were favoring particular occupational groups, such as policemen and firemen, who work at night. After their shift is over, say at midnight, or two in the morning, they can get in line and have hunting. The other thing is that you favor particular age groups that can stand the test. To get away from this, we went to pre-hunt registration. It has further distributed goose hunting opportunities to more people.

For example, there are 71 counties in the State of Wisconsin. We now have one or more hunters from each of the 71 counties using one public hunting ground of roughly 2,000 acres in size.

MR. WHITLOCK: I have to agree with you that it would distribute hunting opportunities to a wider age class, let us say, some people who are really physically unable to sleep in the car or in a sleeping bag or under adverse weather conditions. I think you are dead right about that.

DR. MENDALL: It doesn't look like situations like this are going to get better. Hunting pressure is increasing and is going to increase more.

TECHNICAL SESSIONS

Tuesday Morning—March 3

Chairman: JACK H. BERRYMAN
Assistant Regional Supervisor, Branch of Federal Aid, U. S. Fish and Wildlife Service, Minneapolis, Minnesota

Discussion Leader: L. G. MACNAMARA
Superintendent of Wildlife Management, New Jersey Division of Fish and Game, Trenton, New Jersey

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FIELD AND FARM RESOURCES

IS THE LINCOLN INDEX RELIABLE FOR COTTONTAIL CENSUSING?[1]

TONY J. PETERLE AND LEE EBERHARDT[2]

Michigan Department of Conservation, Lansing, Michigan

Ultimately, the results of our search for a sound and effective habitat improvement program must be expressed as actual numbers of additional animals produced by our efforts. In our present-day economy, where it seems that every production item must be assigned a dollar and cents value, the wildlife manager finds himself in a rather compromising situation. In their perpetual battle with governing bodies over adequate funds, wildlife administrators are murmuring, "Praise the Lord and pass the ammunition," but our ammunition is in short supply and frequently loaded with blanks. Pulling (1940) in a rather philosophical discussion of census needs stated, "The principal value of an exact count to the skilled game manager is proof to politicians and skeptics that he knows what he is talking about." We submit that with increasing pressure on

[1]A contribution from Federal Aid Projects W-40-R and W-96-R, Game Division, Michigan Department of Conservation; data gathered by the staff of the Rose Lake Wildlife Experiment Station.

[2]In the absence of the authors, this paper was presented by Dr. S. C. Whitlock.

our game habitat, convincing the skeptics will be one of our most important jobs.

THE LITERATURE

The development of an adequate census method for cottontails was one of the first inquiries to receive the game technician's attention. Edminister (1937) recognized the difficulty in determining actual population density estimates from field data. In his study, tracks, rabbits started, and predator kills served as indices of abundance in comparing two areas. Allen (1938) used "tag" returns from hunting to estimate rabbit populations on a 500-acre Michigan farm. Dalke and Sime (1938) in a continuous trapping effort to determine home ranges and movements of cottontails in Connecticut, found that "there is a decided sex difference in rabbits reentering the traps." Males seemed more difficult to retrap. The hunting season record as an indication of rabbit abundance was considered unreliable by Burroughs (1939). Hendrickson (1939) summarized Iowa studies of rabbit census methods utilizing pellet and roadside counts. A system of index traplines to compare population densities was suggested by Haugen (1940). In his studies of the cottontail in southwestern Michigan, Haugen (1942) also counted fecal pellets to determine an index to rabbit use of brushpiles.

Schwartz (1941) in his investigations of the home range of Missouri cottontails found "no constant relationship between the number of traps set and the number of rabbits caught per month." In a comprehensive review of census techniques, Studholme (1943) listed drives, trapping, pellet counts and track counts for the cottontail. The population trend of Wisconsin rabbits was determined by plotting the number of rabbits flushed per hour of hunting (McCabe, 1943). The practicability of roadside censuses was discussed by Siegler and Newman (1944). Sight records of rabbits during a winter census in Missouri (Crawford, 1946) failed to serve as an accurate index to the population. The utilization of habitat improvement plantings in Illinois was demonstrated by a trap sample coupled with a census drive (Wandell, 1948). Roadside counts of cottontails are reliable for indicating population trends in West Virginia (Dahl, 1954). A comparison of changes in population levels brought about by habitat improvement was discussed by Bowers (1954). He estimated numbers from capture and recapture data, coupled with "observation of and recovery of marked animals." Moore (1955) suggests the use of box-trap strip censuses for rabbits. Of five methods tested by Cruden and Hendrickson (1955) a modified form of the Lincoln Index was thought most nearly accurate in computing populations from trap-retrap data. Geis (1955) found that a considerable error in population estimates might occur using trap-retrap data only. The Lincoln Index method of estimating rabbit populations in Pennsylvania was "not too reliable for the month of October" (McDowell, 1955). Redd (1956) further emphasized the difficulty in estimating populations from trap data alone. His investigation showed that the trap-retrap method of computing populations was "questionable unless approximately 40 percent of the estimated population is handled." A considerable refinement in the technique for estimating rabbit (***Oryctolagus***) populations from the density of fecal pellets on the ground was made by Taylor and Williams (1956) in New Zealand. Their procedure involved methods for determining pellet density, deposition and decomposition rates. An incidence of coprophagy in the cottontail was reported by Kirkpatrick (1956), which if quite common, would distort population estimates by pellet density. Newman (1957) discussed weather factors influencing the reliability of roadside counts in Iowa. A high degree of correlation between July roadside counts and fall hunting success was observed by Wight (1959) in Missouri.

This review of the literature is by no means complete, but it does serve to emphasize the need for and importance assigned to the development of a method for censusing cottontails. The rabbit is an important game species to millions of hunters. A recent survey (Davis, 1957) showed that 30 per cent of all the shotgun shells fired in the United States had the cottontail as their target.

BACKGROUND

We are interested primarily in a rabbit census method which will provide an accurate local population density estimate, not in indices which show general trends in statewide populations. Research on possible methods has been carried out on farmland and lands abandoned from farming at the Rose Lake Wildlife Experiment Station near Lansing in southcentral Michigan since 1938. We still don't have the answer. A description of the study area, hunting pressure and kill data, and research objectives are given by Ruhl (1947) and Black (1953). Some of the techniques which have been and are being evaluated at this station are roadside counts, the Lincoln Index, pellet censuses, and regression estimates from trap and kill data. Briefly, the roadside count was too variable for our area of 3,000 acres, requiring an excessive number of census miles for reliable results. Difficulties in the development of the pellet census are mainly concerned with the distribution of pellets caused by seasonal cover preferences; winter droppings are frequently under water when counts are made in the spring. A highly variable rate of pellet decomposition, depending on cover type, makes aging of pellets difficult if not impossible. Some pellets may remain distinguishable for as long as three years. Five years of pellet censuses have not provided satisfactory population estimates.

Any method for projecting trapping or kill data must consider that all rabbits are not equally vulnerable to the trap or gun. An analysis of six years of trapping and kill data by Peterle (1957) showed significant differences between the age ratios obtained from the two sources. In five of six years hunters shot proportionately more juveniles than appeared in the trap sample. Since we feel that either the kill sample and/or the trap sample might be biased, computing population densities from either source singly may not give reliable estimates.

THE LINCOLN INDEX

In the remainder of this paper, our major concern will be with the apparent shortcomings of the Lincoln Index as used at Rose Lake to estimate fall rabbit populations. The discussion here is confined to the period 1951-57 and will be largely speculative, since at this writing we are still studying the data. We suspect, furthermore, that we will not be able to obtain a wholly satisfactory appraisal of the method until a rather drastic revision of our trapping program has been in effect for several years. No such revised program is yet in effect—in fact, we have stopped rabbit trapping at Rose Lake until we can complete an analysis of the available data. We feel that the chances for success of a new system depend very heavily on whether or not we can, by deduction from the past records, learn enough to design a method which will meet the assumptions implicit in tag-recovery methods of population estimation.

DeLury (1954) has described the "assumptions underlying estimation of mobile populations" very clearly, and in an easily read, generally non-mathematical manner. We will here be principally concerned with "sampling" assumptions (placement and recovery of tags) and will not discuss movements to and from the study area as a source of bias. We have as yet found little evidence to support the notion that our troubles may be caused by immigration to and emigration from the Rose Lake rabbit population.

Our dilemma can be described very briefly by saying that we trap intensively in what seems to us to be the best rabbit cover, and we *suspect* that hunters also concentrate their efforts on these same areas. The results are illustrated in Figures 1 and 2, showing a

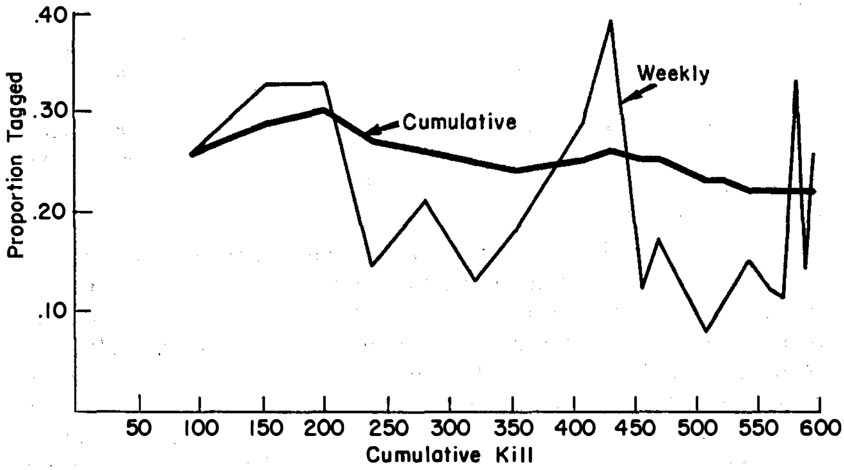

Figure 1.

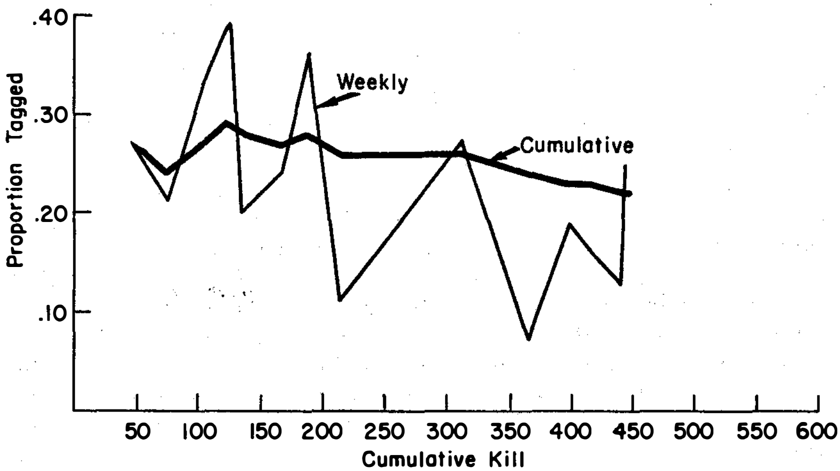

Figure 2.

steady decline in the proportion of marked rabbits in the cumulated kill, as though tagged individuals are being removed at a greater rate than untagged rabbits. Only two of seven years (1951-57) are shown here, but all years exhibit similar trends.

This conclusion is not readily apparent from a study of trapline placement. Cover on the area is varied and well interspersed with open areas, and nearly all cover "edges" contain traplines. Trapping for Lincoln Index estimates is conducted in September and October, just prior to the mid-October hunting season opening. Overall average trap density is about one trap per 5.6 acres. However, if the area is subdivided into ten-acre squares, just about half of these units do not contain traps. Hunting pressure exceeds 300 gun hours per 100 acres.

A number of studies on various species has suggested that trapping will not ordinarily obtain a random sample of an animal population in the sense that each animal in the population will have the same probability of capture throughout the trapping. With the system used at Rose Lake, we have not assumed that random trapping would occur, but we had taken as valid the assumption that tagged and untagged animals would be equally vulnerable to hunting. Excepting movement to and from the area, the evident failure of this assumption seems due either to the tagged individuals being inherently more vulnerable to hunting, or belonging to some more heavily hunted sub-population. The first possibility is one for which we do not have much useful information. The second alternative may be considered as suggested above, a result of higher hunting effort in the areas where tagging was done, or a result of greater vulnerability to both trapping and hunting on the part of some subpopulation. (*i.e.,* one sex or age class).

Proportional tag returns from hunting (Table 1) do differ by sex and age (adults combined due to small numbers). This evidence suggests (apart from any effect of movement and non-hunting mortality) that juvenile males are most vulnerable to hunting; that juvenile females are intermediate; and adults least vulnerable. These differences, in themselves, are not sufficient to explain the time-related decline in proportion tagged in the kill, unless there is also a difference in tagging rates by age and/or sex. We have not completely explored the data in this respect, but we note here that all three classes (juvenile males, juvenile females, and adults) show a decline in the proportion tagged as the hunting season progresses, with juvenile males usually showing the most pronounced decline. This seems to lend support to the thesis that selection for tagged animals results from higher hunting effort on the trapline areas.

Figure 3 shows age ratios (juveniles/adults) in the kill and in the trapped sample for the period 1951-57 (age ratios from earlier years are of doubtful value). The marked differences between kill and trap age ratios seem explicable, in part at least, on the basis of

TABLE 1. PROPORTION OF TAGGED RABBITS RECOVERED[1] BY HUNTERS AT ROSE LAKE

Year	Juveniles Males	Juveniles Females	Adults	Total Rabbits Tagged
1951	.39	.32	.22	181
1952	.33	.28	.35	167
1953	.36	.41	.33	266
1954	.64	.40	.31	245
1955	.53	.48	.25	292
1956	.32	.36	.22	197
1957	.43	.39	.32	335
Averages	.43	.38	.28	

[1]These rates are computed from recoveries in the hunting season immediately following trapping and do not include recoveries i nsubsequent years. Since presentation of this paper, we have adjusted these recovery rates for errors in field aging (on the basis of humerus inspection of shot rabbits) and find differences between classes much less pronounced.

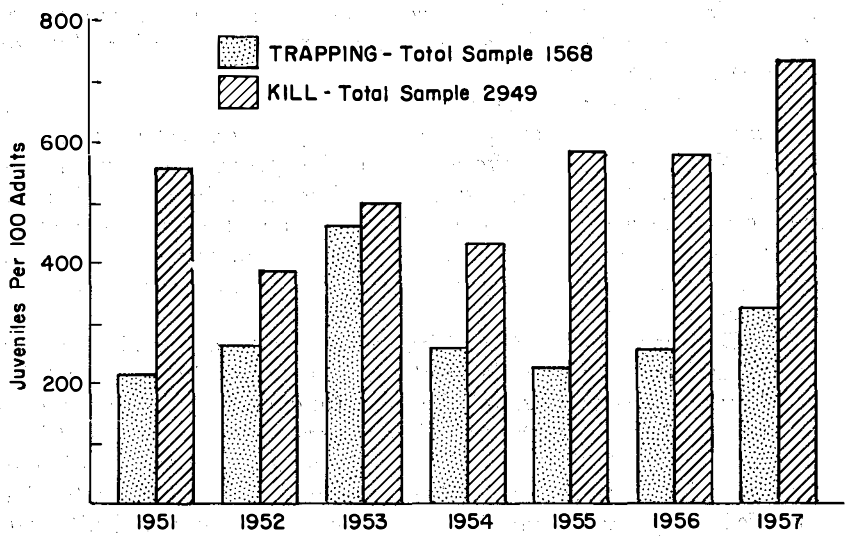

Figure 3.

greater juvenile vulnerability to hunting. A change (decrease) in the age ratio in the bag as the hunting season progresses would seem a necessary corollary to this explanation, but is not clearly evident in our data. We introduce a further complication too, by assuming that rabbits in the trapline areas are subjected to higher hunting pressure; so we are not as yet in a position to suggest how great a seasonal change in age ratios in the bag should occur. We also see no solid basis for asserting that the age ratio in the trapped sample is in fact the ratio prevailing in the population at the time of trapping (*i.e.,* juveniles may be more or less vulnerable to trapping than are adults). Aside from the issues being discussed here, these differing recovery rates suggest difficulties in interpretation of age ratios, similar to those discussed by Eberhardt and Blouch (1955) for pheasants (kill age ratios exceed true ratios and vary with hunting effort).

OTHER ASPECTS

We have not attempted to go into all of the details of the available data here because of limitations in space and the fact that several aspects of the data have not as yet been analyzed to our satisfaction. We note the following angles of our study not described above:

(1) If our thesis of differential hunting effort is correct, and the differential remains relatively constant, then the Lincoln Index population estimate will be an underestimate until *all* rabbits on the area have been harvested.

(2) Sex and age differences in vulnerability to hunting might be compensated for by computing these populations separately.

(3) We have noted differences in the proportion tagged and proportions of tags recovered by hunting in different sections of the Rose Lake area, but these differences can also be corrected by separate computations, excepting that the item of our major concern (differential hunting effort) apparently operates on a very small scale—cover "edges."

(4) We suppose that the ultimate answer to our difficulty may lie in locating traps essentially at random (probably in a stratified sampling scheme) throughout the area (and possibly in re-randomization several times in the trapping program) and note that Chapman and Junge (1956) have described methods for "estimation of the size of a stratified animal population." We anticipate that stratified sampling in trapping will be expensive and difficult (*e.g.,* randomly-located traps will be less efficient; and some areas too wet to trap in September).

(5) Results of statistical (Chi-square) tests have not been given here, but show, in the aggregate, significant differences for major points discussed in the paper.

SUMMARY

The decline in the proportion of tagged rabbits in the kill as the hunting season progresses at Michigan's Rose Lake Wildlife Experiment Station, violates one of the assumptions basic to use of the Lincoln Index. We suspect that higher hunting effort in the trapline areas caused this decline.

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DISCUSSION

MR. ALPAUGH [New Jersey]: We recovered a female rabbit this fall which was trapped in 1952.

DR. WHITLOCK: The point I wanted to make is that at Rose Lake we had a rabbit that escaped the hunters on Rose Lake for four years. Every day they roughly average three man hours of hunting for every acre on this particular site. It has the highest hunting pressure of any area we know of in the State of Michigan. It is quite close to the big city and is open for hunting. We have a fairly long rabbit season. That was one of the points I wanted to make.

MR. MATHER [Alabama]: Is it possible that the hunting around Rose Lake might, as the season progresses, reduce the population to the point where you would get an ingress from the outside that would reduce the percentage of tagged animals that were taken?

DR. WHITLOCK: That is a good point and one of the first things that was thought of. But the authors had no good evidence to show that there was any great drifting in or out. Certainly that is a point that has to be considered, and the only way you could get around it, would be with a rabbit-proof fence or do the work on an island, so that you would know there would be no possibility of immigration or migration.

DR. TRIPPENSEE [Massachusetts]: Did I understand that you found fewer tagged rabbits as the season advanced?

DR. WHITLOCK: Yes.

DR. TRIPPENSEE: Isn't that just saying that the hunters are taking a normal sample? That is, if you shoot rabbits, you shoot tagged rabbits, which are a cross-section of the population, and for every rabbit you shoot, you have one less in the population.

DR. WHITLOCK: The proportion drops.

DR. TRIPPENSEE: There are a couple of other points there that could be straightened out. This matter of tagging or trapping and tagging is a difficult one to interpret in that you are bound to have rabbits going out to agricultural areas during the summer and then drifting back to brushy areas, or areas of protection. There is no point in trying to trap them except if you want to tabulate your trap line, and therefore you are going to find them in areas of cover.

DR. WHITLOCK: I mentioned that the intensive trapping effort is just prior to the hunting season. It doesn't cover more than two weeks.

DR. TRIPPENSEE: But you trap them where they are, is that right?

DR. WHITLOCK: Yes, that's right.

DR. TRIPPENSEE: Would you have some figures on normal cruising radius? By finding where they are trapped one time, and where the same tagged animal is trapped later, the farthest distance is supposedly the cruising area.

DR. WHITLOCK: I don't believe that is a true figure in that we don't know from how far they come. A rabbit, if it finds no place to go, because the cover is depleted, on a field or pasture field, will keep on going. I don't feel we have very good figures on how far they will travel. They will travel until they find a place where there is forage for them.

DR. TRIPPENSEE: Now, one other point. We hate to admit it but I am convinced that the female rabbit—as in the human population, is smarter than the male and also that the female is able to take care of herself better than the male. This is one of the things, I believe, that makes the cottontail such a good game animal, because the productive sex is the one that is protected.

DR. WHITLOCK: The data that these people have obtained would indicate that that is a point—that "the female is more deadly than the male"—or words to that effect.

MR. LORD [Illinois]: Do you know how they determine the age of rabbits in their traps?

DR. WHITLOCK: Do you mean juveniles versus adults in the traps? They depended on development of mammary glands and genital organs in determining age. The rabbits that are brought in by hunters are fluoroscoped.

MR. LORD: Of course, you run into the problem of juvenile breeding. Juvenile rabbits begin to breed, starting in July, August and September.

DR. WHITLOCK: The age/sex ratios, as determined by the trapping just prior to the hunting season, agree almost perfectly with the ratios of rabbits that are brought in. We feel that their methods of ageing and sexing are close enough, at least.

QUESTIONER [Michigan]: Do you know if there is any alternative method of determining the population against which this method could be compared?

DR. WHITLOCK: They have tried roadside counts, but in an area like Rose Lake you would have to cover too many miles. There are about 3,500 acres up there and after some experience, they felt that the variability was too great. Pellet counts have been used but they have run into trouble there. As all of you know, there are different rates of pellet decomposition, depending on the cover. Sometimes rabbits occupy areas in the winter that are covered with water in the spring and the summer. The authors and people who have worked with them at Rose Lake have come to the conclusion that pellet count in that particular area, and all other methods have defects.

SAME QUESTIONER: It doesn't seem that there is sufficient evidence here to indicate that the Lincoln Index method would not work if the various sex and age groups were separated.

DR. WHITLOCK: You mean if each is calculated on its own? I can't discuss that particular point very well. That is one thing they have thought of.

Changing the trapping system, they feel, would make some difference but, as I said before, it is expensive, it takes many more man-hours, and it is less productive in terms of animals caught than the methods that have been used—concentrating the traps in the areas where they know rabbits are more numerous. Perhaps some stratified method probably would work better.

WIDE-ROW CORN AS A GAME MANAGEMENT TOOL

PAUL A. VOHS, JR.

Cooperative Wildlife Research, Southern Illinois University, Carbondale, Illinois

Wildlife habitat for upland game is losing out on lands which are devoted primarily to the production of agricultural crops, although there are farm surpluses now. The increasing human population makes it essential that every effort be made to ensure progressively greater yields of food and fiber in the not too distant future. Thus, wildlife on agricultural lands will be subject to continued attrition unless wildlife managers find techniques for providing habitat which are compatible with farm programs.

Growing of wide-row corn is a cultural practice which has a potential for improving habitat for game on corn land. In wide-row corn culture, the distance between the corn rows is increased, and grass and legume seedings are established between the rows. From the standpoint of wildlife management, a wide-row field differs from the conventional corn field in that food and cover are added between the rows. Because wide-row corn has agricultural as well as wildlife values, it provides a possible meeting place for the farmer and wildlife manager (Vohs 1957).

This investigation of the responses of wildlife to wide-row corn was initiated in June, 1955, as a three-year cooperative undertaking of the Illinois Natural History Survey and Southern Illinois University's Cooperative Wildlife Research Laboratory. The Illinois Department of Conservation and the U. S. Bureau of Sport Fisheries and Wildlife became active participants in August, 1955, when the study was established as a Pittman-Robertson project.

Several row spacings were studied during the first year, but rows spaced 60 inches apart used during the remaining two years proved to be of optimum spacing, because corn yields closely approximated yields from conventional plantings. The development of the interseedings in the 60-inch spacings was enhanced by the even distribution of the corn rows; the corn plants were less crowded within rows; and uniform modification of equipment was possible. Other wide-row spacings will provide the same soil improvement potential, but a 10 to 20 per cent reduction in corn yields can be expected.

Wide-row corn with a grass and legume interplanting between the rows offered several important advantages to the farmer over other methods of corn culture. These were listed by Crabb (1952) as: (1) providing a cover for cornfield soils during the six months that the fields were generally idle and exposed to weathering and erosion; (2) under favorable conditions a legume cover crop in corn could remove nitrogen from the air and add it to the soil; (3) a green manure crop would be available for plowing down to provide much-needed organic material; (4) livestock farmers would have additional pasture without reducing row-crop acreage; and (5) a four-year rotation could be shortened to three years by replacing oats with wide-row corn as a companion crop to establish a grass-legume pasture or meadow.

RESPONSE OF GAME SPECIES

Bobwhite quail.—The value of wide-row cornfields to quail was evaluated in terms of the numbers of quail seen or interpreted to have been present from sign in the wide-row fields as compared with similar data for adjacent fields of standard-interval corn. The fields were searched regularly for quail and quail sign; trips were scheduled so that an equal amount of time per acre was spent in each of the paired fields.

Each quail observed when flushed from within a field was considered an observation-unit. If quail were not flushed but their sign found, an effort was made to determine the number of individuals using the fields. Thus, the number of observation-units equals the number of quail observed plus the number estimated on the basis of sign when quail were not seen.

A comparison of the utilization of the wide-row and conventional corn plantings by quail showed that wide-row cornfields were utilized to a greater extent than control fields in every month for which observations were made. The observation-units of quail per acre totaled 17.5 for the wide-row fields as compared to 3.6 for the adjacent control fields of conventional corn plantings.

Cottontail rabbit.—Pellet censuses, live trapping, flush counts, and sign reading were used to determine the relative utilization of the habitat provided in wide-row and control cornfields by cottontails. Live trapping was carried on throughout the investigation, but this technique, despite continued refinement, failed to yield results which were suited to measurement of utilization. Pellet and flush counts proved much more useful. Pellet censuses consisted of examining 100 samples, 1 square foot in size, in each field each month during 1955-56. The sample size was doubled during 1956-57 and 1957-58 and taken along pre-determined lines. Only those pellets believed to have been recently deposited were counted.

Pellet censuses showed a higher degree of utilization for the wide-row fields as compared with the adjacent conventional corn fields. A mean of 0.75 $\pm$ .32 pellets per square foot per month was calculated for the wide-row fields while a mean of 0.14 ± .07 pellets per square foot per month was recorded for the control plots.

Canada geese.—The Crab Orchard National Wildlife Refuge, utilized during 1955-56, was the only site selected specifically for study of the use of wide-row plantings by waterfowl. However, when waterfowl made unanticipated use of other experimental fields, additional information on the potential of wide-row corn in waterfowl management was obtained.

Greater numbers of geese were supported over a longer period of time in the wide-row fields because the food supply was vastly increased by the provision of grain and browse in the same field. Wide-row corn could possibly be an important management method for waterfowl refuges in the corn-growing regions, especially where refuge lands are taxed to produce sufficient food.

Mourning doves.—The number of mourning doves flushed by an observer initially entering and moving across the fields at 20-foot intervals was recorded at each visit. Each dove flushed was counted as one observation unit.

A total of 4,397 observation-units of doves was tallied in the wide-row fields as compared with 515 observation-units in the control fields. On a per acre basis, 73.9 observation-units were made in the wide-row fields and only 9.7 per acre for the control fields. November, December, January and February were the months in which the greatest number of observation-units were recorded for the wide-row fields. Far greater numbers of doves were attracted to the wide-row fields following the harvesting of corn, when food in the form of Korean lespedeza, millet, soybeans, sudangrass, and cowpeas became available.

DISCUSSION

The value of "edge" and diversification of habitat have long been understood as primary principles of farm land management for wildlife. Wide-row cornfields provide both of these. Changes in vegetation, constituting "edge," occur throughout the fields minimizing the field border effect and allowing game species to make use of the interior as well as the borders of the wide-row fields. Diversification occurs in wide-row fields because forage or meadow crops are produced in conjunction with row crops. Concentrated grains and forage are available in the same field and protective cover is provided.

Food is more abundant in the wide-row fields than in conventional corn plantings when both annual seed producing plants and forage species are included in the interseeding mixture. Seeds and vegetative forage are provided for increased numbers of wildlife over a longer period of time. The carrying capacity of a farm for game will be increased if wide-row corn replaces conventional plantings.

The establishment of grasses and legumes the previous summer in the wide-row fields will allow early spring development of the plant species. This spring growth could possibly provide cover suitable for early spring nesting of pheasants and cottontails. Cover provided by the developing interseeding during the summer of establishment might be suitable for late nesting.

Public and private shooting preserves could benefit by planting corn in wide-rows and interseeding with grass and legumes in place of standard-interval cornfields. The additional food, cover, and diversification of habitat could possibly improve conditions for native as well as for released birds. In a sense, wide-row corn used in this manner would increase and improve upon the capacity of the land to support hunting.

Management programs of wildlife refuges could be benefited by wide-row corn culture. Additional forage could be provided on waterfowl refuges where populations of puddle ducks and geese are limited by the food producing capacity of refuge lands. On pheasant areas additional loafing, feeding and nesting cover could be provided. More acreage in this type of semigrassland agriculture might provide part of the answer to saving the diminishing prairie chicken population in Illinois where row crops replaced the growing of redtop grass seed.

An improved agricultural practice, wide-row corn should be acceptable to the farmer. Though the problem of adjusting farm equipment is present, the benefits derived far outweigh this disadvantage. Soil protection, soil improvement, maintenance of yield nearly equal to standard corn culture and improved systems of rotation, are some of the advantages which are available when wide-row corn replaces the conventional method. More forage and pasture lands would be available without removing any acreage from row crops. Wide-row corn can be advocated as a sound agricultural practice and will provide a wildlife management tool for improving habitat in row crop fields with a minimum of special effort on the part of the farmers.

ACKNOWLEDGMENTS

Dr. W. D. Klimstra, Director, Cooperative Wildlife Research, Southern Illinois University; Dr. Thomas G. Scott, Head, Section of Wildlife Research, Natural History Survey; and Mr. Thomas R. Evans, Superintendent, Game Management Division, Illinois Department of Conservation, provided encouragement, supervision,

administration, and coordination during the course of this study. Mr. Rollie Conder Jr., Field Assistant on the project, aided materially in the field activities.

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DISCUSSION

MR. LAMB [New Mexico]: Do geese come into these wide-row cornfields? The goose ordinarily doesn't like to come into a normal cornfield before it is harvested, and I wondered about wide-row field.

MR. VOHS: That is an excellent question. We planted the corn at Crab Orchard National Wildlife Refuge in 120-inch wide rows alternated with 40-inch conventional planting, and there was no utilization of the wide rows.

MR. LAMB: The corn had to be knocked down before the geese came?

MR. VOHS: Had food at that time been critical, then there might have been some utilization of these wide-row plantings.

This wide-row corn was brought to the attention of the agricultural people by some farmers in Carroll County, Indiana, and as far as I know, successful farmers in some of the farm journals have written innumerable articles on this, and quite a number of farmers have adopted this technique.

One of the problems is the conversion of farm equipment. Depending on what they have it can be done relatively cheaply.

MR. KLEP [Wisconsin]: I was wondering what difference you found between the different spacings in the rows as far as usage goes by the different species.

In connection with this, in instances where we might not be concerned with the yield of the corn itself, does the usage increase as the width of the spacing increases?

MR. VOHS: We used the 60-inch spacing in the final two years and the three alternate systems the first year and found there was no difference. In fact, we had high utilization at all times. The width made no difference.

MR. KLEPDINGER: We can assume, then, that it wouldn't make any difference the other way?

MR. VOHS: I wouldn't think so.

CHAIRMAN BERRYMAN: I would like to offer one further comment. In response to Sam Lamb's question, the Bureau of Sport Fisheries and Wildlife in the North Central Region has done some experimental work with wide-row corn as a goose management technique, and I believe with encouraging results.

AN EVALUATION OF WOODY COVER PLANTINGS AS PHEASANT WINTER COVER[1]

L. JACK LYON

Colorado Game and Fish Department, Denver

In Colorado, as elsewhere, sportsmen and wildlife managers have been appalled by the enormous number of pheasants and other wildlife lost in the occasional severe blizzards characteristic of the Great Plains. Following one of these blizzards, in early January, 1949, it was estimated that up to 80 per cent of the pheasants in northeastern Colorado had been killed by the freezing winds and heavy snow. Observations by conservation officers and biologists in the first two weeks after the storm showed that the only large concentrations of surviving pheasants were in windbreaks and tree claims. Based on these observations, and on the glowing predictions for woody habitat-improvement cover appearing in wildlife literature, it was assumed that the plantings were responsible for the survival of the observed birds. As a logical development, in the spring of 1949, the Colorado Game and Fish Department launched an ambitious habitat-improvement program designed primarily to furnish winter cover for pheasants by duplicating already existing windbreak and shelterbelt plantings.

Paradoxically, weather conditions during the winters immediately following 1949 were relatively mild, and no mortality of consequence was recorded. Nesting was successful in 1949, and in less than three years the northeastern Colorado pheasant population had returned to a level considered normal for the habitat. Necessarily, the Game and Fish Department was forced to question whether habitat-improvement money was being wisely invested. Even if the winter-cover plantings were extremely effective—and there was no proof that they were—their cost as blizzard insurance was relatively high when considered in the light of the recovery potential inherent to pheasants. Accordingly, in 1955, an investigation of the influences of woody habitat plantings on pheasant populations was initiated. One facet of this investigation was a study of winter-cover values. The results of three winters of field work are presented in this paper.

PROCEDURES

The basic study method was a systematic search, twice each month from mid-November through March, of 0.23-acre plots (10,000 square

[1]A contribution of the Federal Aid in Wildife Restoration Program.

feet) in a series of woody-cover plantings. The plantings selected were either established, or similar to those established, by the Game and Fish Department. Field data included complete records of the number of pheasant roosting sites on each plot, counts of live birds flushed and comparative estimates of the abundance of additional pheasant sign such as tracks and dusting sites. Scat and roosting sites were destroyed during each search to prevent later replication.

STUDY AREAS

During the investigation, plots in 11 different plantings were examined. Six plots were searched in all three winters, three were searched during two winters and two were searched for only one winter. A few plots were square, but in most cases a rectangular shape was required because plantings were less than 100 feet wide. Plots were usually established midway between one end and the center of the planting. Descriptions of each planting studied are presented in Table 1.

PHEASANT USE OF STUDY PLOTS

In evaluating pheasant use, the most important consideration was assumed to be the number of roosting sites recorded. The presence of pheasants in a planting, or large numbers of tracks and other signs of use, could not, however, be completely ignored. Pheasant use of study plots was, therefore, rated according to an arbitrarily assigned point system in which roosting sites were given the greatest value, but all evidence was accorded some weight in the analyses. It is recognized that this system has little biological basis, but consistency in use gives it a value for comparison of plots. Summaries of use-ratings for plantings searched in 1955-56, 1956-57 and 1957-58, and the rating system, are presented in Table 2.

ANALYSES OF PHEASANT USE

During each year of the study, about half of the plantings examined, but not always the same ones, appeared to have less attraction for pheasants than the others. In 1955-56, for example, ratings on four plantings averaged 42.0 for the winter, while the remaining six averaged only 15.0. In addition, the total use of all plantings fluctuated considerably from one check period to another. Analyses of variance for the separate years demonstrate that most of these differences were statistically significant (Table 3).

TABLE 1. DESCRIPTIONS OF WOODY-COVER PLANTINGS CONTAINING 0.23-ACRE WINTER-COVER STUDY PLOTS, NORTHEASTERN COLORADO.

Study Plot Number	Structural Description	Species Composition[1]	Understory
1	7-row windbreak, rows east-west	North to south: elm, olive, two hackberry, plum, two sandcherry	Cultivated between rows except adjacent to plums
2	6-row windbreak, rows north-south	All elms	Not cultivated, filled with tumbleweeds (*Salsola kali*)
3	6-row windbreak, rows east-west	North to south: two cottonwood, two plum, two cottonwood	Cultivated between rows except adjacent to plums
4	3-row windbreak, rows east-west	All elms	Cultivated between rows, tumbleweeds between trees
5	3-row windbreak, rows east-west	North to south: caragana, elm, olive	Occasional cultivation between rows
6	Waste area planting	Open plum thicket, several black locust and boxelder	Annual and perennial grasses
7	3-row windbreak, rows north-south	All elms	Annual bromegrass and tumbleweeds
8	2-row windbreak, rows east-west	All hackberry	Cultivated outside rows, tumbleweeds between rows
9	2-row windbreak, rows north-south	East to west: pine, juniper	Clean cultivated
10	Waste area planting	Snowberry and green ash	Annual weeds, perennial grasses
11	3-row windbreak, rows east-west	North to south: juniper, two pine (widely spaced)	Annual weeds

[1]TREES: boxelder, *Acer negundo;* hackberry, *Celtis occidentalis;* olive, *Eleagnus angustifolia;* green ash, *Fraxinus pennsylvanica* var. *lanceolate;* cottonwood, *Populus deltoides;* black locust, *Robinia pseudoacacia;* elm, *Ulmus pumila.*
SHRUBS: caragana, *Caragana arborescens;* sandcherry, *Prunus besseyi;* plum, *Prunus americana;* snowberry, *Symphoricarpos occidentalis.*
EVERGREENS: juniper, *Juniperus scopulorum;* pine, *Pinus ponderosa.*

TABLE 2. SUMMARIES[1] OF RATINGS[2] FOR PHEASANT USE OF 0.23-ACRE PLOTS IN WOODY HABITAT-IMPROVEMENT PLANTINGS, BASED ON SEMI-MONTHLY SEARCHES, NOVEMBER 14 THROUGH MARCH 31, 1955-56, 1956-57, 1957-58.

	Total Use of Each Plot During the Winter				Total Use of All Plots by Semi-monthly Periods		
Plot	Year			Check	Year		
Number	1955-56	1956-57	1957-58	Period	1955-56	1956-57	1957-58
1	17	10	16	Nov.			
				2nd	37	3	9
2	38	16	16				
				1st	42	23	6
3	25	30	16	Dec.			
				2nd	29	17	7
4	46	24	15				
				1st	23	19	12
5	46	6	15	Jan.			
				2nd	25	21	2
6	15	5	1				
				1st	30	22	8
7	6	33	....	Feb.			
				2nd	22	29	11
8	19	16	....				
				1st	23	14	10
9	38	23	....	Mar.			
				2nd	27	15	20
10	8	....	....				
11	....	....	6				

[1] *Year*	*Sample Size*	*Mean*	*Standard Deviation*
1955-56	90	2.87	2.22
1956-57	81	2.01	1.83
1957-58	63	1.35	1.30

[2] A few pheasant tracks	1 point
Pheasant sign other than tracks (scat, dust-sites)	1 "
One or more pheasants flushed	1 "
Many pheasant tracks	2 points
One to four roosting sites	3 "
Five to nine roosting sites	4 "
Ten or more roosting sites	5 "

TABLE 3. ANALYSES OF VARIANCE, SEMI-MONTHLY PHEASANT-USE RATINGS OF 0.23-ACRE PLOTS IN WOODY-COVER PLANTINGS, MID-NOVEMBER THROUGH MARCH, 1955-56, 1956-57, 1957-58.

	Analyses of Variance		
Year	Variation Source	Degrees of Freedom	Mean Square[1]
1955-56	Total	89	
(10 plots, N = 90)	Study plots	9	25.48*
	Check periods	8	4.68
	Error	72	2.47
1956-57	Total	80	
(9 plots, N = 81)	Study plots	8	11.32*
	Check periods	8	5.87*
	Error	64	2.09
1957-58	Total	62	
(7 plots, N = 63)	Study plots	6	4.13*
	Check periods	8	3.50*
	Error	48	1.12

[1]Asterisks indicate values significant at .05 or higher levels.

Variations in Use of Plots

Using the method of J. W. Tukey (Snedecor, 1956) for computing differences between plot means, the applicable values of D, which are significant at the 5 per cent level, are 2.4 for 1955-56, 2.2 for 1956-57 and 1.5 for 1957-58.[2]

With these values as a basis for separation, the plots examined each year fall roughly into three classes, as shown in Table 4. For comparative purposes, the plots in the Heavy-use class received significantly more pheasant use than those in the Light-use class.

TABLE 4. PHEASANT USE-CLASS GROUPINGS FOR 11, NUMBERED 0.23-ACRE PLOTS IN WOODY-COVER PLANTINGS, WINTERS OF 1955-56, 1956-57, 1957-58.

Pheasant Use-class	Year 1955-56	1956-57	1957-58
Heavy-use	2,4,5,9	3,7	1,2,3,4,5
Medium-use	3	2,4,8,9	11
Light-use	1,6,7,8,10	1,5,6	6

Pheasant use of plots in the Medium-use class was significantly different only from the extremes of the other two classes.

The groupings in Table 4 demonstrate two important considerations. First, it is apparent that width, composition and understory of woody plantings do not necessarily determine pheasant-use levels. The five plots which appeared most consistently in the Heavy-use and Medium-use classes (2, 3, 4, 5, 9) showed few structural or understory similarities. They ranged in width from two to six rows; in composition from 100 per cent elms through a mixture of deciduous trees and shrubs to all evergreens; and, in the understory, from clean-cultivation to a dense mat of drifted tumbleweeds. The areas which rated consistently low demonstrated almost as wide a range of characteristics, and in some cases appeared to be near duplicates of the best areas except in their attraction for pheasants.

Second, there is an obvious alternation in the ranking of some plantings from one winter to the next. Plots 1, 5 and 7, in particular, showed extreme fluctuations. The factors responsible for this variation were probably not all recognized, but the two most important were considered to be the quality of herbaceous cover adjacent to the plantings and the inherent tendency of some plantings, probably because of their particular location, to accumulate deep, persistent snowdrifts. Neither cover quality nor snowdrift persistence was

[2]D is the product of the standard error of the mean and a factor, Q, which varies according to the number of means compared and the degrees of freedom for error. Q for the tests of plot means in the three winters were, respectively, 4.65, 4.55 and 4.35 (from Snedecor, 1956).

measured quantitatively, but descriptive estimates were compiled. Table 5 lists the single best herbaceous cover adjacent to each plot and the mean comparative depth of persistent snowdrifts during each winter.

TABLE 5. ADJACENT COVER TYPES AND SNOWDRIFT ACCUMULATION ESTIMATES[1] FOR NINE 0.23-ACRE PLOTS IN WOODY-COVER PLANTINGS, WINTERS OF 1955-56, 1956-57, 1957-58.

Plot Number	Winter 1955-56	1956-57	1957-58
1	Heavy weeds Medium drift	Wheat stubble Deep drift	Heavy weeds Small drift
2	Heavy weeds No drift	Wheat stubble Medium drift	Sorghum stubble No drift
3	Light weeds No drift	Wheat stubble Small drift	Sorghum stubble Small drift
4	Wheat stubble No drift	Fallow Small drift	Wheat stubble No drift
5	Wheat stubble No drift	Fallow Medium drift	Wheat stubble No drift
6	Wheat stubble No drift	Sorghum stubble No drift	Wheat stubble No drift
7	Pasture No drift	Wheat stubble Small drift	Plot not searched
8	Wheat stubble No drift	Pasture Medium drift	Plot not searched
9	Wheat stubble No drift	Fallow Medium drift	Plot not searched

[1]Descriptions are intended to convey only the depth which was persistent in the planting for more than a few weeks during the winter. All plantings collected drifting snow, but drifts under three feet deep were not recorded unless they were very persistent (small drift). Medium drifts averaged about four feet and deep drifts ranged up to about eight feet.

Comparison of Tables 4 and 5 offers no reliable measure of correlation between pheasant use of plantings and adjacent cover quality or snowdrift persistence because the samples were so small. There are some indications, however, that significant relationships do exist. Fluctuations in use of areas 5 and 7 showed a very strong direct correlation with cover quality, and, to a lesser degree, fluctuations on areas 3, 4 and 9 followed a similar pattern. In years when wheat stubble or good weed cover was available nearby, the plantings were heavily used by pheasants; in alternate years, with fallow or pasture adjacent, the same plantings were only lightly used.

Pheasant-use patterns for plots 2 and 8 were apparently independent of herbaceous cover because that influence was outweighed by the presence of snowdrifts in the plantings. In fact, pheasant use of every one of the five plots (1, 2, 5, 8, 9) on which persistent drifts four feet and deeper accumulated declined whenever snow and wind combined to cause drifting. Smaller snowdrifts apparently had no influence on pheasant cover-use patterns.

Variations in Use Among Check Periods

During two winters, variation in pheasant use of woody cover from one fortnight to the next was statistically significant. In lieu of attempting to relate pheasant-use extremes with recorded storms, it is possible to use correlation coefficients for use ratings and weather factors as a measure of weather influences. More important, multiple correlation coefficients offer a means of estimating the combined effects of all weather factors. In order to take advantage of available weather data and avoid confounding data from various types of plantings, however, it was necessary to limit calculations to study plots 1 through 6. These plots, which were studied continuously during the three winters, were of deciduous species composition and were all located inside a circle roughly 30 miles in diameter directly south of Julesburg, Colorado. The remaining five plots were either of evergreen composition or were located so far from a weather station that precipitation and temperature data could not be considered entirely reliable.

Temperature and precipitation data were taken from the records of the U. S. Weather Bureau Station at Julesburg, but wind velocities were furnished by the U. S. Dryland Field Station at Akron, Colorado, because the Julesburg station has no anemometer. The Akron station is about 60 miles south of the area in which the study plots were located, but there are no major topographic barriers in the region, and it is believed that the wind-velocity records provide reliable trends.

In Table 6, temperature is expressed as the mean minimum, and wind velocity is expressed as the total of daily-mean wind velocities, for seven days preceding the field checks. This computation was considered adequate, but a more complicated calculation for precipitation was necessary because the influence of a heavy snowfall can continue for more than a week. Accordingly, precipitation variates in Table 6 were determined by totalling all precipitation preceding the field checks and subtracting, as arbitrary estimates of melting rates, 0.02 inches from any precipitation on the seventh day and 0.05 inches per day from each day preceding the seventh.

Coefficients of linear correlation and multiple correlation for pheasant-use ratings and weather factors in each winter of study are presented in the top half of Table 7. These data are too inconsistent to suggest any important pattern of pheasant use of woody cover, but this, in itself, is notable because it indicates that the basic assumption behind the habitat-improvement program could have been fallacious. For, if pheasant concentrations in woody plantings after

TABLE 6. SEMI-MONTHLY SUMMARIES OF PHEASANT USE OF SIX 0.23-ACRE PLOTS IN WOODY DECIDUOUS PLANTINGS; AND TEMPERATURE, PRECIPITATION AND WIND-VELOCITY VARIATES FOR THE WEEK[1] PRECEDING FIELD CHECKS; MID-NOVEMBER THROUGH MARCH, 1955-56, 1956-57, 1957-58.

Year	Semi-monthly Periods								
	November	December		January		February		March	
Variable	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
1955-56									
Rating totals	30	34	23	19	20	19	15	10	17
Temperature	16.1	11.3	16.6	23.1	15.7	2.0	5.9	24.7	29.3
Precipitation	0.19	0.20	0.00	0.01	0.07	0.09	0.26	0.02	0.04
Wind velocity	22.6	30.8	28.7	29.5	23.4	30.3	20.3	51.4	37.2
1956-57									
Rating totals	1	12	3	11	13	15	20	8	8
Temperature	25.7	25.1	21.0	25.6	8.6	8.9	22.6	18.9	25.7
Precipitation	1.21	0.00	0.23	0.00	0.09	0.00	0.00	0.32	0.66
Wind velocity	28.8	33.4	34.7	30.5	36.4	31.4	35.3	44.7	65.0
1957-58									
Rating totals	9	6	5	11	2	7	11	8	20
Temperature	22.3	20.4	18.5	19.0	16.3	12.1	29.4	13.4	27.4
Precipitation	0.21	0.00	0.00	0.01[2]	0.21	0.01[2]	0.22	0.81	0.13
Wind velocity	38.7	35.0	42.1	36.6	50.0	32.9	38.2	40.9	50.5

[1]Temperature variates = mean minimum, and wind-velocity variates = sum of daily-mean wind velocities, for seven days preceding field check. Precipitation variates = sum of daily precipitation preceding check less 0.02 inches on the seventh day and 0.05 inches per day preceding that.

[2]When precipitation was recorded as only a trace, 0.01 inches was used as a maximum estimate to allow statistical procedures.

TABLE 7. COEFFICIENTS OF LINEAR CORRELATION (r) AND MULTIPLE CORRELATION (R) OF PHEASANT-USE RATINGS WITH TEMPERATURE, PRECIPITATION AND WIND VELOCITY FOR SIX 0.23-ACRE PLOTS IN DECIDUOUS PLANTINGS, WINTERS OF 1955-56, 1956-57, 1957-58.

Period	Correlation Coefficients		
Weather Factors	1955-56	1956-57	1957-58
November 15 through March 31 (n = 9)			
Temperature, r	—0.255	—0.355	0.636
Precipitation, r	0.408	—0.745	—0.005
Wind velocity, r	—0.464	—0.081	0.233
Multiple correlation, R	0.508	0.754	0.650
December 15 through March 15 (n = 6)			
Temperature, r	—0.225	—0.185	0.484
Precipitation, r	—0.249	—0.755	0.048
Wind velocity, r	—0.648	—0.254	—0.698
Multiple correlation, R	0.987	0.979	0.933
R^2, adjusted[1]	0.933	0.894	0.678

[1]R^2, adjusted for sample size $= 1 - (1 - R^2)\dfrac{n - 1}{n - m}$

Where n = the number of sets of observations and m = the number of constants in the regression equation.

snowy periods are actually indicative of a cause-effect relationship, the correlation coefficients for snowfall and pheasant use should be consistently high.

Further examination of the basic data reveals that some of the heaviest snowfalls in all three years occurred in November and late March when shelter may not have been required by pheasants. Storms during these periods were characterized by heavy, drifting snow; but there was little record of pheasant mortality. The heaviest snowfall during the three years was recorded in November, 1956, and, although main roads were closed up to a week, and many back roads were closed for over a month, the storm did not kill any perceptible number of birds. Thus, it seems possible that very early or very late storms might not influence pheasant cover-use patterns in the same way as storms during the more critical midwinter period. On the basis of this speculation, correlation coefficients were recalculated, using only the data from the mid-December to mid-March periods. These coefficients are also presented in Table 7.

The perennial strength and uniformity of the multiple correlation of pheasant-use ratings with temperature, precipitation and wind velocity during the midwinter leave little doubt that the combined influences are important. After adjustment of the coefficients of multiple correlation for sample size according to methods described by Ezekial (1941), the "coefficients of multiple determination" (R^2, adjusted) indicate 93.3, 89.4 and 67.8 per cent of all variation was due to the three weather factors. Not too surprisingly, the strength of the coefficients seems to be dependent on the relative severity of winter weather. The strongest relationship was expressed for the hard winter of 1955-56 and the weakest for the mild winter of 1957-58.

Despite the strength of the combined influence, the correlation coefficients for individual weather factors did not remain constant from year to year. This fact deserves further consideration because it suggests that pheasant weather-reaction patterns are evolved each winter and that consistent patterns cannot be expected unless the storms of one winter resemble those of another. Thus, the negative correlation between pheasant-use ratings and precipitation was particularly strong in 1956-57 because the pattern was established when deep snowdrifts of the November storm drove birds out of woody plantings. By contrast, drifting snow was never a problem in 1957-58, and no pattern ever developed. In the same way, pheasant reaction to temperature in 1957-58 was the reverse of that in the two previous winters because the winter of 1957-58 was so much milder. The single weather factor with year-to-year consistency of influence was wind. In every winter, regardless of the other two factors, pheasant use of woody cover was in inverse ratio to wind velocity.

These patterns are somewhat tenuous because they are based solely on correlation coefficients which offer no means of separating the relative strengths of individual weather factors. A more definitive expression of weather influences is provided by the coefficients of partial correlation presented in Table 8. These coefficients express the importance of each variable by measuring how much one variable reduces the variation when all others except it are taken into account. Calculation methods, as described by Ezekial (1941), are based on the decrease in unexplained variance caused by adding an additional variable to the multiple correlation. For example, in 1955-56, considering only temperature and precipitation, multiple correlation (R^2) was 0.364. When wind velocity was also considered, R^2(unajusted) became 0.978. The reduction in unexplained variance amounted to 95.8 per cent through the addition of the wind variable. Adjusted for sample size, this becomes 0.895 (89.5 per cent), and the square root, 0.946, is the coefficient of partial correlation for wind velocity.

Examination of the partial correlation coefficients demonstrates several important relationships. Pheasant cover-use patterns, as suggested by the gross correlation coefficients, were generally unchanged. However, the true strengths of the precipitation variable in 1955-56 and the wind variable in 1956-57 were revealed. The concurrent high values of the partial coefficients are indicative of the degree of interrelationship among weather factors. But the low partial correlation coefficient for precipitation in 1957-58 is also significant because it discloses that the influence of precipitation can be reduced by certain combinations of the other two factors. In 1957-58, mean wind velocity and midwinter precipitation were slightly higher than in the two previous winters, but temperatures were warmer, and

TABLE 8. ADJUSTED[1] COEFFICIENTS OF PARTIAL CORRELATION OF PHEASANT-USE RATINGS WITH TEMPERATURE, PRECIPITATION AND WIND VELOCITY FOR SIX 0.23-ACRE PLOTS IN DECIDUOUS PLANTINGS, DECEMBER 15 THROUGH MARCH 15, 1955-56, 1956-57, 1957-58

	Weather Factor		
Year	Temperature	Precipitation	Wind Velocity
1955-56	0.541	0.937	0.946
1956-57	0.000	0.939	0.863
1957-58	0.553	0.000	0.754

[1]See footnote, Table 7.

the result, probably because of a combination of higher melting rates and crusting in conjunction with windless snowstorms, was that drifting did not occur.

Of the three weather factors examined, there is little doubt that wind was the most consistently important in its influence on pheasant cover-use patterns. Precipitation, under mid-winter weather conditions capable of causing pheasant mortality, was nearly as important as wind, but it was found that precipitation influences can be nullified by certain combinations of the other factors. Temperature, except indirectly through precipitation, had almost no effect on pheasants. In summary, while all three factors affected pheasant cover-use patterns to some extent, both of the determinative factors caused a negative pheasant reaction to deciduous woody cover. The significance of this response can hardly be overemphasized. The exact combinations of wind, snow and cold capable of causing pheasant mortality are not known, but it is obvious that plantings which are consistently deserted by pheasants in response to high winds and heavy snow are not, and cannot be, effective as winter cover.

SUMMARY AND CONCLUSIONS

The field investigation reported in this paper was designed to answer two basic questions about woody windbreak plantings and their relationship to wildlife. First, does such cover provide effective winter shelter for pheasants; and, second, are values received, if any, consistent with the investment of habitat-improvement funds required? Although neither question was answered conclusively, there was ample evidence that the plantings examined in Colorado were not adequate in either respect.

Pheasant use of plantings during the winter was found to be at least partially dependent on both the juxtaposition of good herbaceous cover and the proclivity of individual plantings for collecting snowdrifts. In general, it appeared that pheasant use could never be expected in plantings not bordered by wheat stubble or weedy areas. In addition, those plantings in which deep snowdrifts had collected were avoided by birds.

During the midwinter period, when pheasant mortality due to weather is most likely to occur, the combined influences of temperature, precipitation and wind were almost entirely responsible for periodic fluctuations in pheasant use of deciduous plantings. In the three winters, 67.8 to 93.3 per cent of the variation in use-ratings was mathematically related to these three factors. More important, it was shown that the strong and consistent pheasant reactions elicited by wind and, to a lesser extent, precipitation were the reverse of those desired. That is, throughout the study, pheasants deserted deciduous plantings in response to high winds and heavy snow.

In view of the limited scope of this investigation, the results cannot be considered a blanket indictment of habitat-improvement programs. The response of pheasants to winter weather conditions showed that deciduous woody windbreaks, considered simply as winter cover, probably have no justification in pheasant management. Obviously, if the objective of winter cover is to preserve a seed-stock of birds which will replenish a decimated population, any cover which is avoided by pheasants during blizzard conditions cannot be considered effective.

Nevertheless, this does not eliminate the possibility that woody cover can serve an important function in wildlife management. This study was concerned with only one game species in a single region during the winter period. The original objectives of the Colorado habitat-improvement program were not fulfilled, but this failure cannot be inductively applied to all phases of habitat management. It only emphasizes what many wildlife professionals have already pointed out, "Appropriate research should precede any program for which broad application in the wildlife field is proposed."

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I am indebted to Federal Aid Coordinator Laurence E. Riordan and his staff, and to Director Thomas L. Kimball of the Colorado Game and Fish Department, for encouragement during the field work and for making the study possible. Francis A. Metsger and Richard T. Takes of the Wildlife Habitat Improvement Project generously contributed their assistance in this and other phases of the investigation. Acknowledgment is also accorded Conservation Officer Lloyd W. Triplet, whose reports on the 1949 blizzard, and other observations from a lifetime of game-law enforcement, were invaluable in interpreting my data.

Professor Elmer E. Remmenga of Colorado State University assisted in the initial development of the statistical methods. Finally, I wish to thank Dr. Lee E. Yeager of the Colorado Cooperative Wildlife Research Unit and Dr. Archibald B. Cowan of the University of Michigan for their constructive suggestions during the preparation of the manuscript.

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DISCUSSION

MR. JAMES HALE [Wisconsin]: I would like to inquire if the area in which this movement took place was without winter cover before the plantings were made.

MR. LYON: Essentially all of northeastern Colorado and most of the Great Plains is a wheatland country. The pheasant cover consists almost entirely of wheat stubble from the year before. Some years the cover will run as high as 18 inches, but as winter cover, wheat stubble isn't particularly good because, of course, it will fill up with snow in a real bad blizzard, so I would say that the answer to your question is, yes, there was no winter cover before the plantings were established.

MR. HALE: Do you have any idea what the effect of a similar program might be in an area that already had some winter cover?

MR. LYON: I can't say for sure. I would suspect, though, that the reaction would be the same.

BOBWHITES AND BENEFIT PAYMENTS

THOMAS S. BASKETT AND ROY E. TOMLINSON

Cooperative Wildlife Research Unit, University of Missouri, Columbia[1]

In 1950, M. O. Steen presented a paper at the North American Wildlife Conference which chronicled dramatic increases of bobwhites during a five-year period on the 2,070-acre West Ashland area in central Missouri. Yearly increases followed a program of farm improvement that included construction of farm ponds, application of lime and chemical fertilizers, green manuring, seeding grass and legumes in pastures, field border improvements, and contour farming. Some of the practices were applied to abandoned, eroded portions of the farms, and as Murray (1948) pointed out, more favorable food conditions rapidly resulted. Farmers received AAA (later PMA and ASC) benefit payments for several practices, plus similar amounts from Olin Industries, Inc. Benefit payments were thus doubled to speed action.

[1]U. S. Bureau of Sport Fisheries and Wildlife, Wildlife Management Institute, Missouri Conservation Commission, Edward K. Love Foundation, and University of Missouri Cooperating. The study was aided by a grant from the Conservation Department, Olin Mathieson Chemical Corporation. We are indebted to George L. Quinn, Jack A. Stanford, Howard M. Wight, and J. B. Lewis, of the Missouri Conservation Commission, for advice and assistance, and to Wm. H. Elder for editorial assistance. We are grateful to many others who aided in the field work.

Fall populations of bobwhites climbed steadily from 192 in 1945 to 605 in 1949, when the program was terminated. The rise continued the following year, for (unpublished) census figures provided us by J. A. Stanford show a population of 751 in fall, 1950. Steen (1950) concluded that environmental improvement was responsible for the increased quail populations, and that such environmental improvement can be attained through recommended land use practices which increase agricultural returns as well as wildlife, and for which the Missouri farmer can secure financial and/or technical aid from established land use agencies. In his book, ***Our Wildlife Legacy,*** Durward Allen (1954:84) wrote of the West Ashland project:

> "With increases of this consistency and magnitude, we can hardly doubt that this project demonstrated the validity of a common contention among wildlife biologists: that good agricultural practices plus reasonable consideration for wildlife are the most important part of a management plan for birds and mammals."

It is important to remember that this "reasonable consideration for wildlife" was a primary objective of the West Ashland project. Although many agricultural agencies lent assistance, the program was conceived and planned primarily by men interested in wildlife management, and close supervision in the field was provided by George Quinn, a full-time employee of the Missouri Conservation Commission.

In 1957, eight years after the removal of guidance by wildlife managers and cessation of double benefit payments, we undertook a follow-up study with the aid of a grant from the Conservation Department, Olin Mathieson Chemical Corporation. Our objectives were:

(1) To determine the status of farm ponds, the game coverts around them, and of wildlife borders planted during 1945-49.

(2) To determine the extent of current farmer participation in practices such as those for which double benefit payments were made in 1945-49.

(3) To determine whether bobwhite populations have maintained high levels.

Our field work was terminated in December, 1958.

LAND MANAGEMENT PRACTICES

Land management practices carried out on the West Ashland area during 1945-49 are described below, and the extent of participation

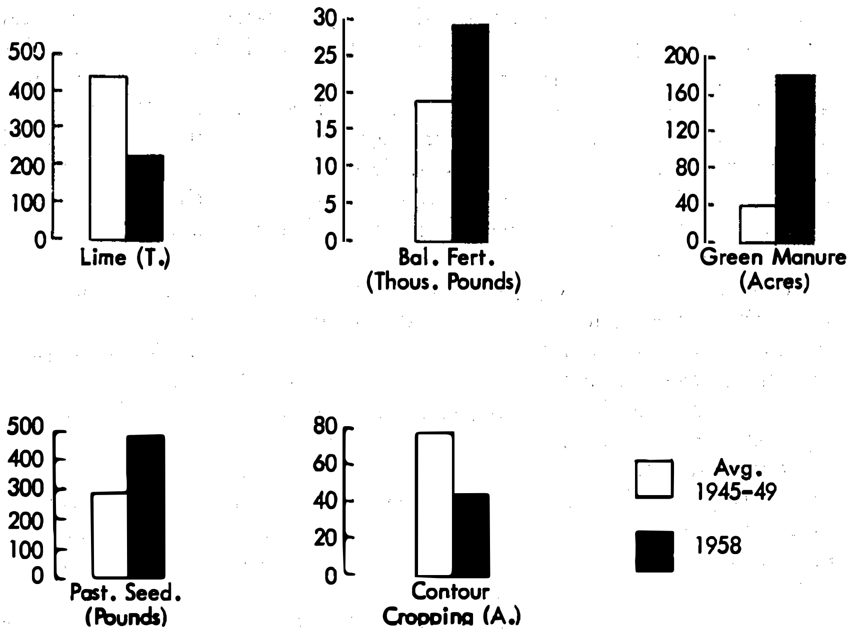

Figure 1. Land Management Practices at West Ashland.

then is compared (text and Figure 1), with more recent participation. Information on the action program was condensed from Steen's *(op. cit.)* paper. Because of the lack of suitable records for some farms, we have used the 1958 data as the principal measure of recent participation.

Farm ponds—1945-49. Thirteen farm ponds were constructed during the action program. All were fenced, and the fenced enclosures, which averaged about two acres, were sown to sweet clover and sericea lespedeza. Virginia and short-leaf pines, blackberry, and black walnut were also planted. Dams were seeded with sod-forming grasses, and multiflora rose was planted around 10 of these pond enclosures. Most of the enclosures had three years to develop as game coverts before termination of the project, and all had at least two years.

1950-58. By 1958, these ponds afforded the principal physical evidence of the West Ashland project. The better ones are surrounded by vigorous multiflora fences, and the enclosures contain dense stands of sericea, grassy areas, and a few blackberry patches.

All 13 ponds have satisfactory water levels. On the basis of the quality of rose hedges and ground cover, we rated four of the pond areas as good game coverts; four as fair; and five as poor. The "good" pond areas have received only accidental grazing or none, and have excellent rose fences and ground cover. The "fair" pond areas have received moderate grazing or none, but either ground cover or hedges are somewhat deficient. Stock was deliberately turned into the "poor" pond areas and there is little or no ground cover. Even the rose fences are poor or absent, and these five have little value for game.

It is difficult to prove that such coverts as these pond enclosures—even the better ones—actually have increased game stands. But we do know that the better ones are used by wildlife. We saw quail at four of them, and were told by farmers who hunt their own land that some are used by quail year after year. Their use by rabbits is striking: four or five of the pond areas are among the coverts most used during winter by cottontails on the entire 2,070-acre area. In winter, songbirds are found consistently in the multiflora fences, and they frequently roost in the conifers. These findings are consistent with those of Greenwell (1948) who made an extensive study of wildlife values of Missouri farm ponds.

Since 1949, ten new farm ponds have been constructed on the West Ashland area. They offer an interesting contrast to the best ponds constructed during 1945-49. No wildlife plantings of any kind were made near nine of the newer ones. Only two are effectively fenced, but one of these is an adjunct to a suburban development, and the enclosure is closely mowed. Three of the new ponds did not actually require fencing because they are not located in pastures. The other five are little more than hog wallows. Only one of the new ponds has much promise for wildlife.

Field border and waste area improvement—1945-49. In the early years of the West Ashland project, 1,000 pounds of sericea lespedeza seed, and 1,160 pounds of sweet clover seed were sown in 25 miles of fencerows. Four-hundred-twenty pounds of red clover seed were sown in field borders and waste areas, and 25,190 trees and shrubs were planted.

1950-58. By 1958, the principal evidence of the earlier field-border and waste-area improvements consisted of patches of sericea lespedeza scattered in fencerows throughout the area, in road ditches, and in heads of small gulleys and other waste areas. It is difficult to assess the value of these to wildlife. Some of the larger areas of sericea which were well-integrated with natural cover were much used by cottontails and quail. Possibly, some of the smaller patches made fencerows and other borders more attractive as travel lanes.

The only field-border or waste-land improvements for wildlife made after 1949 were in 1958 when 5,000 multiflora seedlings and 10 pounds of sericea were planted on one farm. On the other farms, not a single seed of sericea was sown, nor a multiflora rose planted despite the fact that benefit payments were available for these practices. In fact, as we shall see later, some of the natural field borders already present were removed.

Application of lime—1945-49. During this period, 1,738 tons of lime were spread, an average of 435 tons per year (Figure 1).

1957-58. Application of lime is now a common practice at West Ashland. The 1958 figure was 206 tons. Benefit payments are regularly received for spreading of lime.

Application of mixed fertilizers—1945-49. Mixed fertilizers of various analyses applied during 1945-49 totaled 76,320 pounds, an average of about 19,100 pounds each year.

1950-58. Mixed fertilizers are regularly applied to many grain-fields and some renovated pastures. The 29,350 pounds applied in 1958 considerably exceeded the average figure for 1945-49 (Figure 1). Moreover, nearly all the fertilizer applied in 1958 was 12-12-12, a higher analysis than most of the mixtures used in 1945-49, and the 1958 figure does not include nine tons of rock phosphate applied to one field. Benefit payments are being received for application of mixed fertilizers used in pasture renovation, and for application of rock phosphate to hayfields and pastures.

Green manuring—1945-49. Green manure was turned under on 155 acres during the four-year period, an average of 39 acres per year.

1950-58. Green manuring is now practiced frequently on the West Ashland area. The 1958 figure, 171 acres, includes several acres of weedy growth turned under late in the growing season, and because of this is not strictly comparable with the 1945-49 average.

Pasture improvement—1945-49. During this period, 1,100 pounds of bluegrass-Korean lespedeza seed mixture was planted.

1950-58. Seeding of permanent pastures has diminished since 1949, but seeding of oats and Korean lespedeza or of Sudan grass in temporary pastures has increased. In 1958, there were 72 pounds of orchard grass and ladino sown in permanent pasture, and 400 pounds of Sudan grass in temporary pasture.

Contour cropping—1945-49. As many as 120 acres were cropped on the contour in one year during this period. The average figure for the four years was 78 years.

1950-58. Contour cropping decreased considerably after 1949, and in 1958 only 46 acres were cropped on the contour. However, new acreages are now being added through terracing.

Discussion of land management practices since 1949—Some of the farmers of the West Ashland area first gained close familiarity with several of the land management practices described above, and first learned the extent to which the government would grant financial aid for these practices, during the active days of the West Ashland project (Quinn, pers. comm.). With the aid of ASC benefit payments, many of the practices were continued after termination of the project, some actually at higher levels than before. But most practices designed directly for game were dropped immediately, and the cooperative program for land—and wildlife—improvement was soon forgotten.

We thought that changing farm ownership might partially account for the lapse of the program. Twelve of 22 farm tracts changed owners between 1949 and 1958; three of them changed twice. Operators changed even more frequently; there were 22 changes of operators, and three tracts had four operators each during the period. In 1958, some of the new owners knew of the West Ashland project only vaguely, and one had not heard of it, even though one of the fenced ponds was on his property.

But the program actually lapsed as rapidly under original owners and operators as under new ones, and the only farmer who has made recent wildlife habitat improvements, moved to the area since 1949. He is participating in a new demonstration program, guided by a wildlife technician, and supported by the Missouri Conservation Commission and the local Soil Conservation District. He was given the materials he planted: multiflora seedlings, and seeds for food plots and patches of sericea.

BOBWHITE POPULATIONS ON THE WEST ASHLAND AREA

Bird-dog censuses of bobwhites were made on the West Ashland area in early spring, 1958, and again in fall prior to the hunting season. Only 43 quail in five coveys were found during the spring census, and about 305 birds in 20 coveys during the fall census, a density of one bird per 6.8 acres. These figures are compared graphically with those for 1945-1950 in Figure 2.

Although our spring census figure may be low, it does indicate that quail populations have fallen since 1949. Our fall count is better; we made it under difficult cover and weather conditions, but were able to augment the count by tracking in snow soon after the

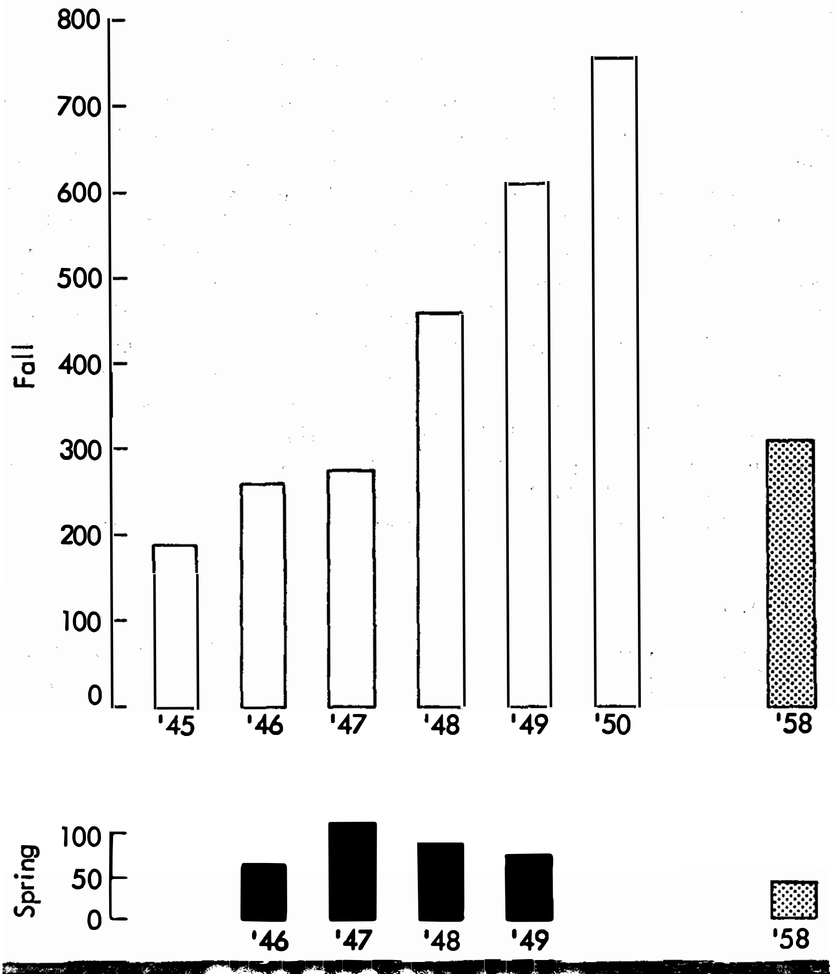

Figure 2. Quail Populations at West Ashland.

hunting season opened, and by reliable reports by farmers of coveys we had missed.

Fall quail populations at West Ashland have remained good enough to attract considerable hunting pressure. But it is clear that despite ASC benefit payments for many of the land management practices encouraged during the program of 1945-49, and despite maturing of some of the game coverts planted during that period, the high fall quail populations of 1949 and 1950 have not been maintained.

THE NEW SALEM AREA

The 2,260-acre New Salem area, one and one-half miles from the West Ashland area, was used as a control during the land management experiment. Quail counts were made only sporadically at New Salem because it was evident that the two areas were not strictly comparable. The New Salem area contains better land, is more level, and more intensively farmed than the West Ashland area. We examined land-use practices on the New Salem area in 1957-58, and carried out quail censuses there in 1958, with the knowledge that it was not a good control because it had undergone much more drastic changes than had the experimental area. Several large farms were now managed intensively for livestock, many natural game coverts had been bulldozed to make way for pasture or cropland, and little game food or cover was left on much of the area. Even though the New Salem area did not serve as a perfect control, its history of quail populations and land use in recent

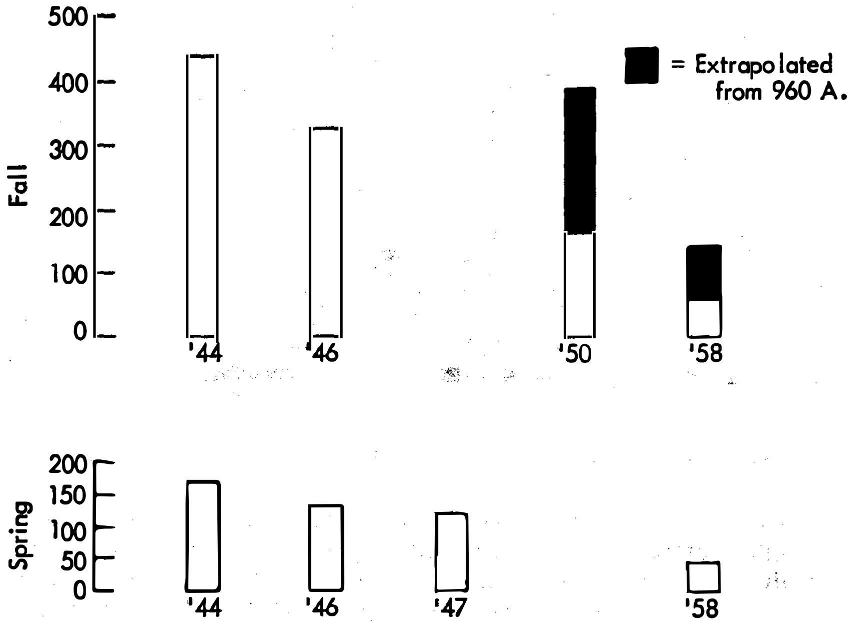

Figure 3. Quail Populations at New Salem.

years is clearer and perhaps more significant than that of the West Ashland area.

New Salem quail populations—The available spring and fall quail population figures for the New Salem area, starting in 1944, are shown in Figure 3. Figures for 1944-1947 are taken from Murray *(op. cit.)* and Steen *(op. cit.)*. In fall, 1950, Missouri Conservation Commission biologists censused 960 acres, roughly the western half of the area. Results of this census were furnished us by J. A. Stanford. This figure is shown in the graph, and to facilitate comparison was extrapolated to the acreage of the entire area.

We counted quail on the entire area in spring, 1958, but in the fall, we covered only the same 960 acres censused by Stanford in 1950. Here, again, our spring figure is probably too low, but it indicates a decline since 1947. We believe our fall count was complete. It shows a substantial decline from the 174 birds found in 1950 to 65 in 1958 (one quail per 14.8 acres). This decline is even more dramatic when one views the 1950 map showing covey locations. Farms on which Stanford found two and three coveys in 1950 now have no quail. One of the farmers who gave us permission to make the quail count remarked that he hoped we enjoyed the exercise.

COMPARISON OF LAND USE TRENDS AT WEST ASHLAND AND NEW SALEM

In fall and winter 1945-46, detailed cover maps of both the West Ashland and New Salem areas were prepared. In 1957-58, we cover-mapped these areas to provide comparisons of acreages in the major land-use categories then and now (Figure 4). It is apparent from the increases in grain acreages that both areas are being more and more intensively farmed, but the West Ashland area has only recently attained the grain acreage that occurred on the New Salem area in 1945.

Woodlots, including wooded hollows fingering into cropped fields, have decreased on both areas, but more rapidly on the New Salem area, where this type of cover was already in rather short supply by 1945. At New Salem, entire systems of wooded hollows were bulldozed, the woodpiles burned, and at best, only narrow grassy or weedy waterways remained in their places. The West Ashland area was much better provided with woody cover in 1957-58 than was the New Salem area. Nevertheless, *ungrazed* woodlots on the West Ashland area decreased from about 180 acres in 1945 to 95 acres in 1957, either through grazing in wooded areas where livestock was formerly excluded, or through removal of trees by bulldozers. This loss was serious, for ungrazed wooded areas are the principal natural heavy cover. In 1957, a few strategically-located wooded hollows were cleared out by bulldozers, in order to permit terracing, and nearly three-fourths of the expense was covered by benefit payments!

Combined acreages of hay and pasture decreased on both areas between 1945 and 1957 (Figure 4). However, this decrease is misleading, because numbers of livestock obviously increased on some farms, especially those on the western half of the New Salem area. Here, intensive management for livestock, accompanied by close grazing of pastures (and clean farming of cropped portions) reduced game habitat drastically. Various types of livestock were involved: sheep, riding horses, cattle, and hogs. These are the farms which have each lost two or three coveys of quail since 1950. As Stoddard (1931:354) intimated years ago, quail are not fond of sheep pastures.

Five of six farm owners in the 960-acre western portion of the New Salem area had recently received benefit payments for such practices as pasture renovation and the application of lime and rock phosphate. The sixth had performed such practices, without the aid of benefit payments. On most of these farms, cropped fields are fertilized annually at recommended levels. At New Salem, fertilizing, liming, pasture renovation and other "good farming" practices, in many cases furthered by benefit payments, have gone hand in

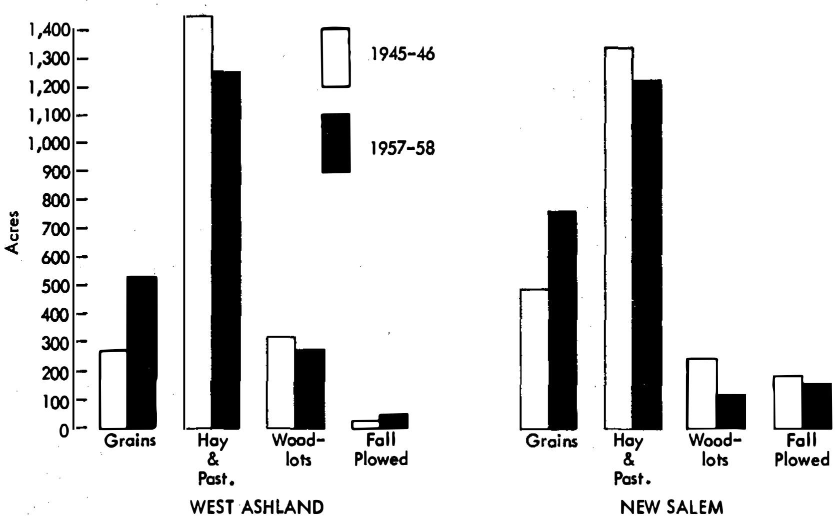

Figure 4. Land Use at West Ashland and New Salem.

hand with extremely intensive farming—and the results have been deleterious to wildlife.

Grazing pressure is not so severe at West Ashland. Where it is heavy, entire farms are not involved, and some good cover usually remains nearby. Clean farming generally has not progressed so far at West Ashland as at New Salem.

To sum up, more and more intensive farming has been the rule on both areas. This trend is much more pronounced on the New Salem area, where entire farms have become virtually untenable for quail since 1950. Differences in quantity of cover on the two areas are illustrated by the fact that the fall quail count in 1958 took twice as long per 100 acres at West Ashland as at New Salem; promising terrain was covered with the same thoroughness on each area. Differences in 1958 fall quail densities reflected these differences in land use on the two areas. We found one quail per 6.8 acres at West Ashland, one per 14.8 acres at New Salem. Cottontails, too, were more abundant at West Ashland: we flushed 2.7 per hour there, and 1.7 per hour at New Salem.

Participation in Soil Bank Program—In view of the increasing intensity of agriculture on both areas, participation in the Soil Bank was of considerable interest. In 1958, four farmers on the West Ashland area participated in the acreage reserve program; 70 acres were reserved. Much of this land had dense stands of tall annual weeds like greater ragweed (*Ambrosia trifida*) or biennials, principally white heath aster (*Aster ericoides*) and gray goldenrod (*Solidago nemoralis*). Korean lespedeza which was present in some of the fields produced little seed because of over-topping by coarse weeds. There were about 160 acres of similarly-vegetated land on the area that were not in the Soil Bank. Apparently, quail use this type of cover but little for nesting (Klimstra and Scott, 1957; Klimstra, *in litt.*), and they used it sparingly in early fall. In late fall, when it might have been more useful, half of it was plowed. These acreage reserve fields were of limited use to quail, but were heavily used by rabbits.

On the western half of the New Salem Area, where cover of any kind was desperately needed, there was no participation in the Soil Bank.

Unfortunately for wildlife, then, the Soil Bank participation was confined to the area where conditions for game were generally good. The reason is obvious: when fertilized at the same rate, New Salem fields produce 100 bushels of corn per acre, but West Ashland fields yield 70 bushels.

DISCUSSION

Murray (*op. cit.*) described habitat changes at West Ashland during the early years of the land management project, asserting:

> ". . . At the beginning of the study, 14 per cent of the farmland had been abandoned and old fallow fields were in the perennial weed-intolerant tree state of succession. This provided good cover but poor food. Some of this idle land has since been returned to cultivation, and where border cover is left food conditions are now more favorable for birds than before. . . ."

Murray noted that the quail ranges with the greatest increase in seedings of Korean lespedeza showed the greatest increase in quail populations. He added that the most luxuriant vegetative growth of lespedeza as well as the heaviest seed crop, was on limed land. When limed fields of lespedeza were within winter covey ranges, they were used constantly for food or cover-roost sites.

Perhaps, then, a key to the rising quail populations at West Ashland was not simply that lime, lespedeza seed, and fertilizer were applied, but that in part they were applied strategically, in the renovation of old fields to produce food interspersed with good cover. The maturing pond enclosures and field border plantings may have contributed to the security of some coveys in the later years of the program, even though cover was not the limiting factor for most covies. But without an adequate control, we cannot dismiss the possibility that there was some increase in quail throughout the entire locality.

There are cases in which declining quail numbers are clearly related to drastic changes in habitat. One example is the decline in quail following removal of brushy cover on an area in Wisconsin (Kabat and Thompson, 1951). The history of diminishing quail populations on the New Salem area from 1950 to 1958 is undoubtedly another. However, we do not understand fully why quail populations declined as much as they did after 1950 at West Ashland.

On a good game area, food and cover relationships are very complex, often interdependent, and difficult to analyze accurately (Schultz and Brooks, 1958). Nevertheless, part of the quail decline at West Ashland seems attributable to declining habitat. As we have shown, soon after 1949, the West Ashland land management program was forgotten, and little was done deliberately for quail. New cover offered by maturing pond enclosures was probably more than offset by the bulldozing of wooded hollows, and the grazing of a greater acreage of wood-lots still further reduced this type of cover. Lime and fertilizer were still spread, but not to renovate old fields near good cover. Increases in crop acreages were made, sometimes at the expense of well-located permanent cover.

But changes in habitat may not be the only reason for the decline in quail on either area, for a slight regionwide decline after 1950 is indicated by Missouri Conservation Commission field bag check data. Quail bagged per gun-hour in this region decreased from 0.87 in 1950 to 0.72 in 1958 (Crawford, 1951a and b; 1959).

Even so, the game and land use histories of these two areas, which extend over several years, clearly illustrate an obvious but important point: without "reasonable consideration for wildlife", benefit payments and the land management practices they encourage, may be of little value for game. Since 1950, at best, they only partially counteracted the harmful effects of more intensive farming on game at West Ashland. At New Salem, they went hand in hand with virtually complete destruction of quail habitat.

SUMMARY

(1) According to an earlier study, yearly increases in quail followed a five-year program of farm improvement on the 2,070-acre West Ashland area in Missouri. This program of pond construction, liming, fertilizing, field-border improvement, and other practices, was speeded by double benefit payments. It was terminated in 1949.

(2) Our study conducted in 1957-58 showed that liming, fertilizing, and many other such practices had been continued on this area and were often supported by ASC benefit payments. However, with no guidance by game managers, few practices now were intended for, or were directly beneficial to wildlife. Although the West Ashland area retained much good game cover in 1957-58, it was being farmed more intensively. Fall quail populations dropped from 751 in 1950 to 305 in 1958. A general decline in the locality may have been partly accountable.

(3) Between 1950 and 1957-58, the New Salem area, located nearby, had undergone drastic reductions in cover and food. Entire systems of wooded hollows had been bulldozed, and several farms were now managed intensively for livestock. Liming, fertilizing, and pasture renovation were regular practices, often with the aid of benefit payments. On 960 acres, fall quail populations dropped from 174 in 1950, to 65 in 1958.

(4) In 1958, Soil Bank participation was limited to the West Ashland area where game conditions were already good. But on the New Salem area, where cover of any kind was needed desperately, land was considered too productive to retire from heavy grazing and tillage.

(5) The history of the two areas since 1950 clearly illustrates that *without consideration for wildlife,* benefit payments and practices they encourage may be of little value for wildlife. At West Ashland, at best, these practices only partially counteracted harmful effects on game of more intensive farming. At New Salem, they went hand in hand with virtually complete destruction of game habitat.

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DISCUSSION

DISCUSSION LEADER MACNAMARA: Thank you, Dr. Baskett.

This is a striking paper. It exemplifies what is happening in many other sections of the United States and it gives an indication that we need extension work even when benefit payments are available.

MR. BAUMGARTNER [Oklahoma]: The situation is different in the plains as far as the effects of the Soil Bank where the immediate response to idle land is a very heavy stand of sunflowers and other heavy seed-bearing weeds. Our experience has been that if someone from the Game Department will actually work with the people in the soil bank, oftentimes we can increase the period of time when definite benefits result. On the other hand, there is the natural inclination on the part of the farmer and on the part of the agriculture people who work with him on the soil bank program to look upon the soil bank as an opportunity to improve pastures as well as build up the general fertility and productivity of the land; so we constantly find that most of the emphasis is directed toward such practices as the sowing of Bermuda grass and the development of other pastures which are of relatively limited value for game. It certainly is up to the wildlife extension man and our Departments that are trying, as far as practical, to give the farmers good information and to encourage them to carry out practices which will have more long-time benefit as far as wildlife is concerned.

DR. BASKETT: I realize there are places and species for which the soil bank program may be very good, and this is no blanket condemnation of that program; but it did not work in the area reported on.

MR. MANGOLD [New Jersey]: How did you account for such large consistent increases in fall populations with concurrent drops in spring populations? Was this increased production of quail, or a movement into the areas?

DR. BASKETT: I hoped you wouldn't bring that up because it is complicated. This question arose when Steen presented his paper back in 1950 and, in part, he explained it on the basis that the increasing harvest on this area reflected increasing proportionate reproduction. There is an opportunity for ingress and egress, particularly on the West Ashland area, because it is a long narrow area—one mile wide.

MR. WORRELL [Colorado]: I would like to ask Dr. Baskett to comment about the relation of food to cover. In either area, was the main decline due to reduction of cover?

DR. BASKETT: At New Salem, where the decline is easy to explain on the basis of land-use changes, I think it could be both. Grazing has taken both out, and bull-dozing has removed cover too.

At West Ashland this is much more complex a problem and is dealt with in detail in the paper itself. I think West Ashland was at a stage when this whole program started where the farming was actually not intensive enough. Food was put next to cover by the program itself, but intensity of farming increased after the program ceased and probably went over the hump so that it has become too intensive. I think in many cases cover is becoming a limiting factor in that area, but it is not nearly so critical as it was at New Salem.

We are surprised at the magnitude of the change at West Ashland.

MR. WALLACE ANDERSON [Minnesota]: I have a comment that may be important to the wildlife managers. The facts that Dr. Baskett has brought out indicate that some kind of follow-up with landowners is necessary if these practices are going to be kept in operation. I think this sort of follow-up, from the experience of people in the Soil Conservation Service, is just as important in getting landowners to maintain strictly soil conservation practices, like terracing, strip-cropping, and other things of that sort, as it is to get them to maintain wildlife practices or soil conservation practices that are beneficial to wildlife.

Dr. Baskett pointed out that the farmers tend to carry out those practices that increased crop yields and therefore increased their incomes. That should tell us something, I think, about the need for providing incentive for landowners to use practices that will increase wildlife. Maybe wildlife needs to be put in the category of a marketable crop.

SOME ASPECTS OF WILDLIFE POPULATION DYNAMICS, THEIR INTERPRETATION AND ROLE IN GAME MANAGEMENT

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While phenomenal increases in the numbers of hunters may continue, limits are being reached in the size of game populations that this country can support. Some unstocked and under-stocked areas still exist, as well as, areas where habitat improvement may boost the size of wildlife populations. Nevertheless, any increases in game from these programs would be unable to keep pace with the increased hunter demand.

More efficient and more intensively planned game management is the only way that game can be provided for the increasing numbers of hunters. Game management's task is to determine then, the size of the largest sustained yield that can be obtained and to learn at what level the game populations should be maintained to produce this yield. In such an approach, consideration must be given to the quality and growth of individual animals as well as to the increase in their numbers.

The major obstacle confronting any intensive management program, is the highly variable environmental influence causing wildlife population fluctuations. Unfortunately, game managers have, at times, overlooked the ecological implications of population fluctuations. Rather than untangling a complex environmental relationship, "shotgun" management measures are all too often adopted to cope with the situation. These efforts have chiefly consisted of (1) preservation of the breeding stock by means of harvest restrictions and predator control, and (2) introduction and replenishment by stocking and transplanting exotic and native game species. All too often, this type of approach has been detrimental to the game resource and misleading to the public.

Because there are conflicts in the interpretation of environmental influences, there is a need to re-examine past wildlife population fluctuations. During the short history of waterfowl censusing, periodic fluctuations in waterfowl have been explained primarily on the basis of over-hunting or breeding-ground deficiencies, *i.e.* lack of water areas and predation. These approaches have failed to explain why in certain years large breeding populations of waterfowl have produced relatively few young. In contrast, other years having low breeding populations have witnessed bumper crops of young.

Data from the Lousana, Alberta waterfowl study area from 1953 through 1958, show that in the years 1954 and 1958 large breeding populations of waterfowl had relatively poor per cent population increases by the following fall, Table 1 (Smith, 1958a, 1958b). In contrast, the years 1953, 1955, and 1957 were years in which low breeding populations produced bumper crops of young. Of particular significance is the fact that in 1957 the numbers of water areas diminished to a record low coincident with a record production of young waterfowl. Also, the nest predation pressure exerted in that year was only ten per cent lower than in 1958 (Table 1) and equal to that exerted in the lowest production year of 1954. Admittedly, an increase of predation and a loss of 31 water areas were responsible for much of the loss of young in 1958. This was not the case in 1954. Water and predation are only two of many environmental factors determining waterfowl production.

TABLE 1. SUMMARY OF WATERFOWL STATISTICS, FOR ALL SPECIES, FROM LOUSANA STUDY AREA, 1953-58 (SMITH, 1958a, 1958b)

	1953	1954[1]	1955	1956	1957[2]	1958[2]
No. breeding pairs	379	517	493	614	664	1087
% Est. nesting success	42	18	48	43	56	45
% Est. nest loss to predators	37	37	39	48	38	47
% Est. spr. to fall pop. increase	132	77	135	130	188	111
Water area status						
May 1	196	191	206	201	189	198
June 1	196	191	197	197	175	167
July 1	193	186	185	193	153	161
Aug. 1	192	163	167	162	122	144

[1]Late spring. [2]Early spring.

In his studies on the effect of starvation on penned wild mallards, Jordan (1953) found that drakes and hens, exposed to spring climatic conditions, died when they lost 55-60 per cent of their original weight. Critical body weights were reached in the third and fourth week of starvation. The gonads of those birds which died in the breeding season were relatively undeveloped. On full diet, following 25 days of starvation, 80 per cent of the original body weight was regained in seven days and nearly 100 per cent was regained in 14 days. No outward symptoms of the previous starvation were observed at 28 days. Jordan suggests that in the wild more birds would succumb as a result of starvation; and in the survivors, the recovery of lost body weight would be slower than in his pen studies.

Siivonen's (1957) investigations suggest that the immediate cause of Finland's autumn grouse population fluctuations is the spring diet and its influence on the hen. This diet must restore as much as

20 per cent of the hens' early spring weight to prevent a decrease in egg-laying, fertility of eggs, clutch size, quality of eggs, hatching, survival of the young, etc. However, Siivonen states that the winter conditions are basically important, for it is then that the spring weight of the grouse is determined.

In his Pelee Island pheasant study, Stokes (1954) found that the later the hatch the lighter the weight of the hen and her young. Also, there was a significant difference in the recovery of banded birds in the fall hunt. The heavier birds were found 10-13 per cent more frequently in the hunters' bag than were the lighter birds. These findings applied to juveniles as well as to those hens that had brought off late hatches. Additional support of Stokes' findings was brought out by Kabat *et al.* (1956). This work suggested that pheasant hens hatched early in the spring may possess a greater ability to withstand stress than late-hatched hens.

The point of speculation now arises as to what degree might these factors influence a waterfowl population to create the fluctuations given in Table 1. The migratory nature of waterfowl would suggest that these factors may be as important or more important than the presence of water or predation. When winter conditions are severe, the waterfowl move further south and therefore more distant from the breeding grounds. Should feed conditions on those southern areas be subnormal, winter weight losses might be very general. Under such conditions, might not spring migrations begin before the birds regain any appreciable weight losses? Enroute to the breeding grounds over the extended migration routes, severe storms and adverse feeding conditions are not uncommon. Jordan's (1953) studies suggest that for those birds surviving, the drain of energy reserves may result in a reduction of the gonads. Even though fatal weight losses are at a minimum, large numbers of waterfowl suffering from starvation, with 35-40 per cent loss of original body weights, could arrive on the breeding grounds.

To all appearances, the numbers of breeding birds would indicate that a production of young proportionate to the breeding population size might be expected. Outwardly, there might be no indication of the lack of physiological capability on the part of the birds to begin the reproductive process. Early abortive nesting may occur, but this may be interpreted as a failure due to a late season or excessive predation. The presence of paired birds well into the breeding season is usually interpreted as the result of early nesting failures and pre-renesting courtship. It would not be apparent the birds were gaining back lost weight and undergoing physiological breeding rehabilitation which may take 14 to 28 days or longer (Jordan, 1953). Late nesting attempts by starving birds might be interpreted as a renesting attempt because of the date and decreased clutch size. This is not saying renesting does not occur; however, it is possible that late nesting and small clutch sizes could indicate late physiological breeding conditioning as well as a renesting attempt. The late nesting observations of Cottam and Glazener (1957) further emphasize the need for further investigation of this problem.

It is conceivable that this physiological conditioning could not be reached early enough for the nesting to take place. Munro (1941) suspected that a certain segment of the lesser scaup population did not breed. As a result, paired birds might be observed retaining full breeding plumage until mid or late summer. Such full plumaged birds were observed during some years on the Lousana area where as high as ten per cent of the mallard population was thought to be in this category.

Despite a sizable waterfowl breeding population, starvation conditions could result in (1) fewer young per adult and (2) the production of lighter bodied young whose survival till fall and through the winter would be low (Stokes, 1954; Kabat *et al.*, 1956). Having subnormal weights as they entered the fall, it is possible that these late-hatched or late-nesting birds would lose more weight under circumstances of little concern to a heavier bodied bird.

A further ramification of this involves the late-hatched juvenile hen. With a loss of weight, would this bird be capable of reproducing in the next season? Ward's observations of coots on Lake Manitoba revealed that some coots were still downy in November 1955. In the spring of 1956, many coots arrived on the breeding grounds in a plumage little advanced over the usual October plumage (Hochbaum, 1958). Is it not possible that some of the waterfowl remaining paired late in the breeding season could then be juvenile birds in a physiological state capable of producing near normal breeding plumage but not having fully developed gonadal structures?

Referring to Table 1, the blizzard conditions in the spring of 1954 accompanied by unusually low temperatures may have induced weight losses severe enough to retard nesting and reproduction. Had the winter conditions been severe, 1958 might well have been a disastrous year for waterfowl. As it was, unusually large wintering populations were recorded in the northern tier of the Plains States. This situation meant shorter spring flights were required to reach the breeding grounds. Because of these factors, the waterfowl probably arrived on the breeding grounds in as good a physiological state as possible. As a result, this condition offset the losses from a lack of water and increased predation which resulted in mediocre waterfowl production instead of a bust.

In 1958 hunting restrictions reducing bag limits for redhead and canvasback ducks over-emphasized the role played by hunting. The fact that the canvasback breeding populations arriving on four breeding areas did not deviate by more than 28,000 (6%) in the last three years (Dillon, 1959) suggests that hunting removal had not been responsible for any important fluctuation in the population numbers of these two species. The need of these hunting restrictions to counteract any influence of lowered water levels on the production of young is yet undetermined.

It appears that some interpretation of population fluctuations of upland game and waterfowl may need revision. The factors influencing production are not entirely bound up in the environment of the breeding ground or in the gun of the hunter. All of the conditions prevailing throughout the entire annual cycle are important and must be considered in the light of their many complex combinations.

This problem of ecological interpretation is not confined solely to avian problems of game management. The famous North Kaibab deer herd has been and is still used as the shining example of predator-prey interaction. The basis for this example is the assumption that the removal of 674 mountain lions, 120 bobcats, and 3,000 coyotes from 1907 to 1923 (Mann and Locke, 1931), caused the phenomenal deer herd irruption. Little attention has been given to the role played by plant succession and livestock grazing during this period. Mann also reported that from 1887-89 at least 200,000 sheep and 20,000 cattle were grazing on the North Kaibab and the surrounding range land. In addition, horses were abundant. In one roundup in 1888, a herd of 1,000 horses were taken across Lee's Ferry for sale in Arizona. From 1906 to 1920 permitted cattle numbers on the North Kaibab alone ranged from 9,000 to 15,000 and sheep from 5,000 to 20,000. Because of the lack of fences, there were probably many more sheep and cattle than the permits allowed. Grassland which was abundant at first deteriorated under this grazing pressure. Browse species invaded the grasslands, and it was probably this food factor which was basically the impetus for the increase of deer from an estimated 4,000 in 1907 to 100,000 in 1924.

A reverse of this was witnessed from 1951-54. Grazing of livestock on the forest was reduced by 45 per cent in 1950. Following this reduction, grass invaded and dominated some of the large browse areas which were under heavy browsing pressure by deer. This further suggests that the role of land use was more important than predators, as the major factor in the large fluctuations of this herd.

This over-emphasis on predation and hunter removal has occurred in other mammalian populations. The Delaney Rim herd was one of the most productive antelope populations in Wyoming. Following the snows of the winter of 1948-49, the population declined and has never recovered. In contrast, the antelope herds of the surrounding areas have returned to their former status, that prior to the 1948 storms. Predator control and removal of hunting pressure have made no noticeable improvement in the Delaney herd production. Research investigations conducted by the Wyoming Game and Fish Laboratory, revealed that the Delaney Rim animals were as fat and carried as many fetuses as those animals of high-producing herds on surrounding ranges with comparable habitat.

One significant result of this investigation was the isolation of a vibriosis organism which causes abortion in sheep (Edwards and Post, 1958; Trueblood, 1959). This organism can be picked up in feed or water. Sheep flocks grazing the areas occupied by the antelope have likewise suffered from low production when compared to other sheep herds in surrounding comparable habitat. Secondly, in an analysis of the antelope liver lipides, Miller (1958) found that the Delaney Rim animals had a significantly higher level of liver lipide than animals of the high producing herds. Such a condition can be caused by malnutrition or detrimental levels of selenium intake.

Ignoring hunting pressure and predation in this situation does not assist in the rehabilitation of the game population. Likewise, ignoring the subtle role of disease and the toxic elements may mean the total destruction of the local dwindling population. The solution depends on placing the proper degree of importance on each factor, considering their influence as a part of a whole, and carrying out an effective game management program.

We all know that for many of our game problems the difficulty lies in an under-harvest. Despite this, stringent harvest regulations are imposed as major decimation controls in many attempts to stabilize our game populations. West Virginia's squirrel populations have fluctuated through periods of abundance and of scarcity since pioneer times. As hunting pressure increased, refuges were established, seasons were shortened, and bag limits were reduced. Despite these measures, the squirrel population continued to undergo repeated fluctuations. Uhlig (1956) found that the natural mortality was three to four times greater than the hunter harvest. It appeared from this study that the length of season was of little importance and in many instances the reduced bag limit accomplished little except to deprive the hunter of some game.

As in Siivonen's grouse work (1957), Uhlig found that the carry-over capacity of the winter environment determines the fall population of squirrels. In those years of poor mast production, a delayed spring breeding season resulted or it was skipped entirely (Uhlig, 1956). Errington (1957) similarly observed that the spring to fall rates in quail population gain were highest for low spring densities and lowest for high spring densities.

The New York and Pennsylvania deer situation parallels the squirrel problem but possibly has more serious implications. Restricted hunting regulations, *i.e.* the spike length and limited doe hunting, have apparently produced a case of chronic malnutrition in these states' deer herds. At one of the informal meetings of the 1958 conference, it was brought out that in certain deer herds in these two states antler development was so retarded that three-year-old bucks were without the legal spike length. This would appear to be a case of chronic malnutrition brought about by over-population and an under-harvest of deer by hunters. In addition, there is the possibility such conditions may also cause variations in tooth development. This in turn may cause misinterpretation of the age structure of the deer herds.

The basic problem is one of forage utilization: as utilization increases, the content of desirable nutrient in the diet decreases. Likewise, the digestibility of the nutrients decreases as the animals are forced to eat the less nutritious parts of the plants. Because of this reduced palatability, the animals daily forage consumption is decreased and this further reduces the actual nutrient intake (Cook, 1956). In many instances, this may result in the production of inferior strains of game animals because of the emphasis on numbers with little regard for quality of the game and the long range capacity of the habitat.

The demands of increasing numbers of sportsmen will require that game management consist of more than preservation of the breeding stock and transplanting or stocking. Game managers need more knowledge of the influence of climate, topography, soil, water, vegetation and that land use by other animals and man. The loss of 17 million acres of rural land since 1942 to such land uses as residential, industrial, and commercial areas, highways, airports, etc., only serves to emphasize the importance of this approach (Suggitt, 1957).

There is no intent to deny the need for harvest control, predator control, etc. However, any increase of game can only be accomplished and maintained with the creation, the improvement, and the management of natural habitat on a long-term basis. Game decreases are almost always the result of a great many factors taken as a whole, not any single element.

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DISCUSSION

DR. DIEM: I would like to add one more comment. This is a problem which is related to many of the research projects which we now have under way. We ought to conduct more intensive investigations of the birds themselves with serious collections on a rather large scale in their breeding grounds, whether it be waterfowl or upland game, prior to and during the breeding season. We would then be able to get some factual reproductive data from a collection of reproductive tracts from these animals.

DR. CHEATUM [New York]: I would like to compliment the author of this paper for bringing to the attention of the administrators and biologists the significance of spring breeding success of populations to what is available for harvest the following fall.

We in New York, by studying and following the effects of hunting pressures on various game populations, have become convinced that the least important factors which influence winter carry-over and the status of breeding the following spring are the seasons and bag limits on those species. We are making a gross mistake when we hold that we must see the results the following spring on breeding flocks before setting seasons and bag limits. The harvest itself has little significance on what happens to those populations in the long term. That is not to say that under certain circumstances in certain areas it is not possible to overharvest a population in some species. I want to emphasize that the factors which underlie reproductive success, which may very well be related to the state of nutrition in which the animal comes into the breeding season whether it is a white-tailed deer, a pheasant, or a duck. This has more fundamental significance than any other single factor in connection with whether or not you are going to have good fall populations.

I just wanted to complement the thoughts that were expressed in this paper, because I think we are going to have to do some re-evaluation and some soul searching, not only among the biologists but also among the administrators.

DR. BAUMGARTNER [Oklahoma]: I would like to second Dr. Cheatum's comments. In the Plains States we have had an amazing upsurge in many kinds of resident animals. In the case of the bobwhite this has taken place despite a real irruption of rodents, particularly pack rats, although, as we all know, pack rats and quail aren't supposed to get along together.

To give you an illustration: on one public hunting area in Oklahoma, the quail kill in 1958 on 8,000 acres was around 40,000 birds and this took place despite the fact that cotton rats were in plague numbers at the same time. I can't help but believe that physiological condition of the bobwhite last winter and during the breeding season must have been superb.

DR. DIEM: This has been the thing that has impressed us in most of our observations in waterfowl and big game.

I would like to add, also, that the thought and work that went toward the making of this paper were not only mine; they were many old ideas that were woven together and particularly I would like to emphasize and acknowledge at this time the assistance and contributions of Mr. Allen G. Smith, who is a biologist, at the Bear River Migratory Bird Refuge, in Brigham City, Utah.

COVER MAPPING A FIVE-MILLION-ACRE STATE FROM AERIAL PHOTOGRAPHS[1]

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Cover mapping the entire state of Massachusetts from aerial photographs has proved to have high utility for wildlife management. The state of Massachusetts with a population of about 5,000,000 people and an area slightly over 5,000,000 acres, ranks as one of the most densely settled states in the country. Approximately 40 per cent of the land area is now closed to hunting (Larson 1958). With a growing population and 300,000 sportsmen seeking lands and waters for hunting and fishing, every acre of wild land or open water still remaining is real estate of priceless value to the sportsman.

The Massachusetts Division of Fisheries and Game has long been cognizant of the pressing problem of hunting space in the state. The situation of an ever-increasing population and ever-decreasing habitat for wildlife is especially critical in a small state with a high population like Massachusetts. Broad statistics on the amount of forest and agricultural land in the state have long been available, but the wildlife biologist needs to know not only how much forest and open land there is, but exactly *where* it is. Whether certain forest types are in large, unbroken stands or in scattered, small units influences the distribution of different species of game. Knowledge of the interspersion and juxtaposition of cover types over extensive areas is basic to sound long-range game management planning based on the ecological community. Massachusetts has several million acres of forest lands of heterogeneous structure from the pitch pine (*Pinus rigida*) and scrub oak (*Quercus ilicifolia*) of Cape Cod to the northern forests of the Berkshire mountains.

To conduct such a survey on the ground would be prohibitively expensive and time consuming. A task, which appeared impossible, became feasible when 1/20,000 panchromatic aerial photographs with complete stereoscopic coverage of the state were taken in 1951 and 1952. Aerial photographs offer many advantages over ground methods in obtaining good cover maps of extensive areas. Other wildlife workers (Leedy 1948) have described possible uses of aerial

[1]This is a contribution of the Massachusetts Cooperative Wildlife Research Unit supported by the U. S. Fish and Wildlife Service, the Massachusetts Division of Fisheries and Game, the University of Massachusetts and the Wildlife Management Institute. This project was also supported partly by the Massachusetts Department of Natural Resources and by federal aid funds as a Pittman-Robertson Project WL27-R.

photographs for such game management purposes as censusing big game and waterfowl, evaluation of game range, mapping, and a number of other uses. When used for making cover maps, game managers have usually used larger scale photographs for restricted areas. In some cases, enlargements are used. Massachusetts studies suggest the best photographs for such purposes are at a scale of 1/7920 (8″ to a mile) taken before foliage has leafed out and with stereoscopic coverage. Even with good, large-scale photographs, photo interpretation must be supplemented with work on the ground for accurate map detail. The techniques used in the project described in this paper were not new, but cover mapping all the vegetation in a state to a minimum unit size of ten acres with such small-scale photographs had never been attempted previously.

The project was started in the fall of 1953 under the supervision of the Massachusetts Cooperative Wildlife Research Unit. Mapping was completed in the fall of 1956. The methods used in this undertaking have been described in detail elsewhere (MacConnell and Garvin 1956a and MacConnell 1957b). For convenience and clarity, I shall briefly review the classification system.

CLASSIFICATION SYSTEM

Complete stereoscopic coverage of the state required approximately 6000 aerial photographs. The photographs taken when the deciduous trees were in leaf presented serious problems in photo interpretation of wildlife habitat. In developing a classification system, only those types which could be consistently recognized under all conditions by an experienced photo interpreter were mapped. Lester Garvin and Roger Rich, both graduate assistants in the Massachusetts Cooperative Wildlife Research Unit, spent months in field reconnaissance with photos and stereoscope in hand to determine the most complete possible wildlife habitat classification system. Limitations of the photographs were quickly discovered, and a theoretical proposed system was greatly modified so that a high degree of accuracy in typing could be attained. The land was broadly divided into forest land, open land, wet land, and urban land. The sub-divisions of these broad land classes were determined by the limitations of 1:20,000 scale aerial photographs and are as follows:

Forest land:—the species were grouped and classified into four categories:

S—softwoods constitute at least 80 per cent of the stand.
H—hardwoods constitute at least 80 per cent of the stand.
HS—a mixture of hardwoods and softwoods with hardwoods predominating.

SH—a mixture of softwoods and hardwoods with softwoods predominating.

Pl—plantations are indicated by appending the symbol Pl to the forest type symbol.

Although the interpreters could not consistently separate the softwood species on the airphotos, a knowledge of the ecology of the state makes a good estimate possible. For example, 80 per cent of the softwood on Cape Cod is pitch pine (*Pinus rigida*); spruce (*Picea rubrum*) occurs in quantity only in the Berkshires, and hemlock (*Tsuga canadensis*) grows mainly on north-facing slopes. Since ten-foot contours and the over-all land use pattern appear on the maps, the user is in a position to appraise elevation, location, exposure, and other ecological factors in judging whether the softwood shown on the map is likely to be pine (*Pinus strobus*), spruce, or hemlock.

The height classes used were:

1 1 ft.-20 ft.
2 21 ft.-40 ft.
3 41 ft.-60 ft.
4 61 ft.-80 ft.
5 81 ft.-100 ft.
6 Uneven heights (three or more height classes represented).

The Density classes were:

A Good stocking, 81 to 100 per cent crown closure.
B Fair stocking, 51 to 80 per cent crown closure.
C Poor stocking, 30 to 50 per cent crown closure.

This code method of classifying or typing forest stands lists species, height, and then density as in the following examples:

H2A is a hardwood stand 21 to 40 feet in height with good stocking.

HS5A is a mixture of hardwoods and softwoods with hardwoods predominating. The stand is 81 to 100 feet tall with good stocking.

S3B is a softwood stand 41 to 60 feet in height with fair stocking.

$\frac{\text{H3C}}{\text{H1B}}$ is a hardwood stand 41 to 60 feet in height with poor stocking over hardwood 1 to 20 feet in height, with fair stocking.

Seventy-two one-storied forest stands are recognized in this classification. Recognition of more than 200 different forest stands is possible, counting both one-storied and two-storied situations. Two-storied classifications may be used to indicate cut-over areas or abandoned fields (AF) growing back to forest. The following examples are typical.

$\frac{\text{H3C}}{\text{SH1A}}$ is a scattered overstory of hardwoods 40′-60′ in height and an understory of mixed stand with softwood dominant 1′-20′ in height.

$\frac{\text{S1B}}{\text{AF}}$ is an abandoned field with 51-80 per cent of the field covered with softwood 1′-20′ in height.

Open land:—

AL is agricultural land intensively farmed. This type consists of nearly all open, continuous fields with no stonewalls, hedgerows, small patches of abandoned land, small forested areas, or wet land. Much of the intensive agriculture carried on in Massachusetts falls into this type.

AL-I is agricultural land interspersed with stonewalls, hedgerows, small forested areas, patch of abandoned land, or wet land. This type is more productive of wildlife than AL.

AL-M is agricultural land with a small, fresh-water meadow present. If the meadow were ten acres or larger, it would be separated and classified as FM described later. The darker green reeds in a meadow give a lower spectral reflectance than the surrounding grasses and sedges, distinctly revealing the field drainage pattern.

AF is abandoned field which is reverting to forest land. The woody vegetation on these fields has a crown closure of less than 30 per cent. Because this type is so interesting to foresters, wildlife biologists, and agriculturists, it was colored a rather violent pink on the maps.

O is productive fruit orchard.

AO is abandoned orchard. Separation between orchards in use and abandoned orchards is simple on aerial photos. This separation has importance when evaluating orchards for wildlife habitat; the productive orchards have only minor wildlife value while abandoned orchards are exceptionally good wildlife habitat.

CB is cranberry bog.

U is urban or industrial area.

Wet land:—

The wet-land classification follows, with a few modifications, the types defined by the Branch of River Basins of the Fish and Wildlife Service. Their classification was simplified so that wet-land separation could be made consistently on the existing aerial photographs of Massachusetts.

FM is fresh-water meadow. The principal means of separating this type is by identifying a reed (*Juncus* spp.) which commonly grows in the wetter parts of meadows. The type is often found in pastured agricultural land.

SFM is shallow fresh-water marsh, a wetter type than FM. This type has little open water or woody vegetation. The predominant vegetation is usually cattails, and the soil is completely waterlogged or covered with water up to several inches in depth.

DFM is deep fresh-water marsh which is wetter than SFM. This type has open water interspersed with patches of vegetation. Water ranges from six inches to three feet in depth, and the vegetation is a scattered floating type.

SS is a shrub swamp. The type is fairly easy to identify on aerial photographs and USGS sheets may be used to verify the swamp condition.

Vegetation in wooded swamps is designated by the forest land symbols described above. After the forest has been classified on the aerial photographs, the information is transferred to USGS sheets which have swamp symbols showing the extent of swamps.

SM is salt marsh. Five coastal saline types are recognized by the Fish and Wildlife Service classification of wet land. A strong effort was made to make the five separations, but all had to be consolidated into one type (SM) which could be consistently separated under all conditions on the aerial photographs. Tides make separation of salt marshes very difficult on aerial photos. The interpreter would need to know the time of day and the date the pictures were taken to appraise the kind of salt marsh viewed.

These types were outlined in India ink on the aerial photographs. Using a sketchmaster, the type lines on the aerial photographs were transferred to U. S. Geological Survey topographic sheets at a scale of 2 inches to the mile. To a map showing both planimetric and topographic detail has been added the vegetation which clothes the land. Symbols for aerial photographic centers and photo key numbers were added to the maps so that a photograph covering a certain area can easily be pulled from the file or ordered for those who want more details. After the types were inked on these maps, they were reproduced in quantity. These prints have little utility unless colored. The originals were colored grouping certain forest, open land and wetland types under 27 different colors. Following this step, acreages of all the classes of land described above were tabulated for townships, counties, and some watershed areas.

The maps and area statistics have great utility to the wildlife biologist and administrator, and new uses for these maps become apparent month by month. Some current uses for the wildlife professional are discussed.

AREAS FOR STOCKING PHEASANTS, SNOWSHOE HARES AND BEAVER

Until recently, stocking of pheasants and snowshoe hares in Massachusetts was a hit-or-miss proposition. With an accelerated research program and a reorganization of the Division of Fisheries and Game, all stocking was placed in the hands of trained wildlife biologists. They used the maps to plan the stocking program, but proposed stocking areas were field checked before actual stocking took place. Many new, good habitats have been discovered, and the maps have saved countless man hours of field investigations. Transplanting nuisance beavers is a perennial state problem, and the maps have been used to select suitable release spots well removed from dwellings and roads.

The utility of the maps for stocking has been of great importance from a public relations viewpoint. When wildlife biologists were placed in charge of stocking, many sportsmen questioned the basis on which stocking areas would be selected. District game managers have reported that they have been criticized by club members who ask just how they know which covers are most suitable for stocking and sometimes have flatly stated that the stocking is guesswork. When shown the cover maps, skeptical sportsmen have been surprised and impressed with the Division's policy of stocking suitable areas on an objective, impartial and non-political basis.

EVALUATION OF LAND FOR PURCHASE AND MANAGEMENT PURPOSES

The Massachusetts Division of Fisheries and Game has entered a wide-scale program of purchasing tracts of land for the development of public hunting grounds. These type maps have proved invaluable as an aid in evaluating possible tracts as present and potential wildlife habitat before purchase. They have provided an efficient and time-saving aid in laying out management plans for those lands under the Division's control. In converting large areas into tracts suitable for farm or forest game species, these maps enable the manager to pick parcels of cutover land, abandoned farm land, swamp and marsh land which can be cleared or linked together to form units of habitat which will afford hunting.

The maps have been used in selecting small marsh areas for possible impoundments. The wetland survey of the U. S. Fish and Wildlife Service inventoried marsh areas of 40 acres or more. The Massachusetts type maps supplement the federal survey by inventorying marshes or wet areas of ten acres or more. In the case of the classification AL-M (agricultural lands of poor drainage) wet areas down to five acres have been depicted.

It is possible to learn acreages of the state suited primarily for forest game species or farm game species, and management policies for certain areas can be based on the type of habitat already existent. Some public lands are managed for quail, pheasants or cottontail rabbits while others may be managed primarily for ruffed grouse, snowshoe hare or woodcock.

Woodcock, ruffed grouse and quail are all inventoried by making counts of singing, drumming or whistling male birds in the spring or early summer. Quail census routes have been laid out in a random fashion in quail range. A study of the maps established high correlation between certain types of agricultural land and number of whistling quail (Ripley and Garvin 1955). Ruffed grouse census routes of 15 miles each have been laid out in the state with the use of cover maps. Research studies have indicated a good correlation between grouse numbers and certain stages of forest succession combined with quantity and juxtaposition of conifers. Woodcock census routes are not random, but run in woodcock habitat. Woodcock habitat is usually limited to areas of early forest succession, and census routes can be readily picked out from the maps.

Biologists are often faced with inventorying game or cover on a sample basis. Picking a true random sample presents problems. By knowing how many acres of different forest and open land types there are in the state as well as knowing exactly where these areas are greatly simplifies the technique of selecting a sample of cover types truly representative of the state.

Studies could be instituted which would indicate the total acreages of different kinds of game cover in existence in the state. By knowing the stage of plant succession in 1951 and 1952 when the photographs were made, it should be possible to forecast with considerable accuracy habitat changes due to forest succession or land practices which might take place in the next few decades.

Since land vegetation is dynamic and continually changing, it would be ideal if this entire project could be repeated in 15 or 20 years to determine trends in land changes. Even if the project is not repeated, it establishes a permanent picture of the land in Massachusetts in 1951 and 1952 which may be used as a yardstick to measure land changes in future years.

COST OF PROJECT

There are 186 U. S. Geological Survey Maps covering Massachusetts. One of these completed, including typing, transfer of types to topographic sheets, coloring and tabulation of acreages, represented 50 skilled man hours per sheet. Most of the work was done by men who were graduate students trained at the University. The cost, excluding the cost of the photography, amounted to approximately ½¢ per acre or $3.20 per square mile. Good figures on cost are difficult to compute since space, some equipment, materials, and much free time have been contributed by cooperating agencies. It is safe to say that work of this kind can be done for less than 1¢ an acre if the area is fairly large and the photography has been done. It is estimated that photography alone would cost twice that amount. Factors influencing cost include quality and scale of photography, proficiency of photo interpreters and especially the extent of diversity of the land types.

OTHER USES

Many other agencies and individuals have found these maps of high utility. The Army Engineers, watershed agencies, Soil Conservation Service, State land planning agencies, tax assessors, agriculture economists, foresters, and lumber concerns are among the groups who are using them.

SUMMARY

Aerial photographs at a scale 1/20,000 were made of the state of Massachusetts in 1951 and 1952 when the deciduous trees were in leaf. Under the supervision of the Massachusetts Cooperative Wildlife Research Unit, a unique project of cover mapping the entire state down to areas as small as 10 acres from these photographs was undertaken. The development of techniques required several months of preliminary work. Although such cover mapping from aerial photographs is not new, no area of over 5,000,000 acres of diverse habitat has ever been cover mapped in such detail. Therefore, some new techniques and land type classifications had to be developed. The mapping included symbols for forests according to species, height and density, open lands including abandoned fields, agricultural lands, orchards, abandoned orchards, cranberry bogs, shrub swamps, and other categories. Wetlands of all types made up the third classification group. By using accepted photogrammetric techniques, the typing on the aerial photographs was transferred to the 186 geologic survey maps of the state at a scale of 1/31,680 and reproduced in some quantity. The file copies were colored according to vegetative types.

To a map showing both planmetric and topographic detail has been added the invaluable information on the exact location and juxtaposition of all types of game cover. In addition, exact acreages and location of these types has been tabulated for every town and county in the state. The cost of the entire project, excluding the cost of photography, was approximately ½c per acre. One completed colored map represented 50 skilled man hours of labor.

The utility of this tool in the hands of game administrators and wildlife biologists is proving very high. It is possible to evaluate game habitat on a broad basis with the information on the types. The stages of forest succession determine suitability of habitat for various upland species. Such stages are clearly shown on these maps. Census lines for such upland species as quail, ruffed grouse and woodcock are first laid out on these maps and later field checked. Habitat types on land available for purchase by the state is known. The location of small wetlands for development of waterfowl areas is depicted. Countless man hours of field work as saved by being able to do preliminary intelligent planning in the office. Secondary uses of these maps for other public agencies have proved many fold. Foresters, agricultural economists, fruit growers, soil conservationists, watershed agencies, town and regional planners, land tax agencies, commercial lumber concerns and others have created a demand for copies of these maps, and the tabulated type area statistics which are now available.

ACKNOWLEDGMENTS

Major credit for the completion of this project belongs to the photograph interpreters, Lester Garvin and Roger Rich. Most of the technical training was accomplished by Professor William P. MacConnell of the Department of Forestry and Wildlife Management of the University of Massachusetts.

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TWO DECADES OF PROGRESS ON WISCONSIN'S PUBLIC HUNTING AND FISHING GROUNDS PROGRAM

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The responsibility of providing sportsmen with a place to hunt and fish has been in most states assigned to conservation departments. Twenty years ago, the legislature gave the Wisconsin Conservation Department the first legal and financial provisions for meeting this obligation. The purpose of this paper is to review the development of the program through these first two decades and to analyze future programs and problems.

LEGISLATION

In Wisconsin, the public hunting and fishing grounds program owes its existence to the passage of two very effective statutes. The first, passed in 1937, provided for a new type of license called the Voluntary Sportsmen's License which sold for a minimum of \$5.00 and permitted hunting, fishing and trapping all with this one license. Of this fee, \$2.00, plus any added contribution by the buyer, was earmarked for the purpose of "acquiring lands for game refuges and public hunting and fishing grounds". The cost of the Voluntary Sportsmen's License today has risen to \$10.00, of which \$2.50 is earmarked for public hunting and fishing grounds. In 1938, 648 of these licenses were sold; in 1958, 51,669 were sold. Contributions over the minimum fee, although never appreciable, average around \$1,200.00 annually. Through fiscal year 1958, 456,337 Voluntary Sportsmen's Licenses have been sold, producing a revenue of \$2,944,035. Many sportsmen pride themselves on holding a Voluntary Sportsmen's License and it has provided a part of the necessary financial base with which to operate the program.

The Voluntary Sportsmen's License Fund was insufficient to carry out a large-scale effort and the 1943 legislature gave the program tremendous impetus by increasing the small game license fee 50 cents and earmarking this income for "acquisition, maintenance and administration of public hunting and fishing grounds, and the adjustment and payment of damages. . . ." Present earmarking is limited to 25 per cent of the small game license revenue for acquisition, leasing, development, maintenance, and the payment of damages on public hunting and fishing grounds.

THE SYSTEM

1. *Leasing.* In 1937, interest in a public hunting and fishing grounds program developed because closure of land to sportsmen was reaching a high level in the intensively populated regions of the state. Although the amount of posting was not measured at that time, it was obvious that needs were greatest in east central and southern Wisconsin. Projects were established on that premise.

In 1956, a car transect survey was conducted on land posting during the small game season to provide additional criteria for planning our program. The results were as follows: In northwestern Wisconsin (forest-farm fringe, few people) only 3.2 per cent of the area sampled was posted. In northeastern Wisconsin (similar to northwestern but more heavily developed for resorts) only 10.6 per cent was posted. In west central Wisconsin (combination farm-forest-hill country) 4.4 per cent was posted. In east central Wisconsin (largely farm land—contains the industrialized Fox River Valley and Green Bay areas) the amount of posted land was 24.6 per cent; however, one-third of the best game range, the marsh lands, was posted. In southern Wisconsin (almost exclusively farm and urban) 24.6 per cent was posted; more importantly, however, was the fact that 79 per cent of the unpastured marsh, 63 per cent of the swamp, 48 per cent of the woodlots, and 41 per cent of the unpastured meadow was closed to sportsmen. Statewide, the ratio of signs which completely excluded sportsmen to those which provided access by permission was five to one.

Lease areas are selected on the basis of present cover conditions, wildlife population and general public need. Each landowner is contacted to secure a lease covering hunting and/or fishing rights on his property. The lease provides for annual payment, usually 20 cents. Some fishing areas provide for much higher payment because small acreages along streams are leased. The state assumes responsibility for sportsman damage. There are no restrictions on the owner's use of the land. A closed area is created around buildings. Vehicle parking is regulated. Trapping rights, and on some fishing areas, the hunting right, may be reserved by the landowner. There is no minimum size. Each area is treated as an individual problem, and if not enough land in the particular case is obtained by lease, the prospective area is dropped. Leases on new areas ordinarily are taken for one year on a trial basis. Leases on old areas ordinarily are taken for either three or five years, or the period most desired by the majority of landowners.

Generally, the leased projects are selected where a marsh nucleus exists. In Wisconsin, marshes are closely associated with pheasant hunting. In 1955, we checked hunters to determine, quantitively, the importance of marshes to pheasant kills. Of the hunters checked in two townships in which marsh cover made up 20 per cent of the total area, 60 per cent of the pheasant kill was made in or on the edges of marshes.

The first leased public hunting grounds was established near Madison and comprised 1,280 acres. This project is still functioning and now consists of 2,528 acres. By 1949, there were 233,321 acres under lease on 77 different areas. As of January 1, 1959, there were 257,710 acres on 153 areas under lease. Mention should also be made of the 57,000-acre Meadow Valley Unit of the Central Wisconsin Conservation Area under lease for game purposes from the Department of the Interior to the state.

The increase in the number of projects is due, in part, to lease of streams for fishing, and secondly, the lease of lands for sharp-tailed grouse management. The latter program was made possible in 1953 when the legislature, at the department's request, made it possible for counties to withdraw lands from the provisions of the county forest crop law and lease them to the state for game management purposes. The annual payment for this lease has been 20 cents which by law is prorated to the county, the towns and the respective school districts. Although we currently manage sharp-tailed grouse on 116,404 acres, we lease only 45,000 acres for this program, while the balance is accomplished under cooperative agreement with counties, the state forestry division and the U. S. Forest Service.

Although the 1937 legislature did not make provision for the department to pay damages caused by sportsmen, the 1943 legislature did. Game managers were apprehensive that damage payments might become excessive. Our experience is contrary, however, to popular misconceptions that sportsmen damage is serious in terms of excessive financial loss. From 1944, the first year, through 1957, there were 258 claims amounting to $9,218.86, or an average of $35.73 per claim. The average annual cost for damages has been an amazingly low figure of $658.00. About one-third of the claims are for damage to fences and other property, one-third for livestock and fowl, 12 per cent for game bird damage to crops, 10 per cent for hunter damage to crops and the balance for miscellaneous. The largest claim of $350.00 was for a killed cow. Farmer attitude and rather strict claim procedures have eliminated any abuses of the damage clause. There have been only isolated instances when the integrity of the landowner was questionable.

Many leased public hunting grounds support good pheasant populations. Because hunter pressure is extremely heavy, however, the department supplements wild populations by stocking of adult cocks prior to and during the season. In 1958, for example, the number of birds released was 32,637. Studies were made for ten years on immature pheasant cocks released at 10-12 weeks of age in late August and September on 21 different public hunting grounds. On these areas, an average of 51 per cent of the cocks were recovered by hunters. On heavily hunted areas releases are made immediately before and also during the season. The recovery rate is somewhat higher and offsets the increased cost of holding birds to this age. The importance of a stocking program to provide game on the public hunting grounds is also demonstrated by the fact that on areas checked, 50 to 70 per cent of the pheasant kill is from game farm birds (Kabat, 1955).

Sportsmen's clubs cooperating with the department's day-old chick program annually release around 180,000 8- to 12-week pheasants, many of which go on department leased projects. A third type of release is made in July of adult hens and cocks used for breeding purposes. In 1958, this totaled 22,848, many of which went on public hunting grounds.

Sportsman use of public hunting grounds is extremely high on opening week ends after which it drops to a low on week days and increases again on subsequent week ends, but never to the first weekend high. For example, a complete check on the Mazomanie Public Hunting Grounds in 1952 showed 57 per cent of all hunters checked used the area on opening week end; 15 per cent on the second week end; the remaining use took place on week days and the last two week ends of the season. Hunter use on most other areas is typical of this area.

To obtain data on the use and importance of public hunting grounds to the city sportsman, we kept data on the residence of 16,884 hunters checked during the 1949 season. More than 29 per cent came from 13 cities in east central and southern Wisconsin. One in every ten checked lived in the city of Milwaukee. As would be expected, these data are a marked contrast to the 1956 National Survey of Hunters and Fishermen for Wisconsin which showed a much higher per cent of the rural population holding hunting licenses than urban people. Obviously, the city resident has to rely heavily on state areas in place of hunting on private lands.

To round out the picture on leased projects and their importance to the Wisconsin hunter, in 1950 we mail-sampled small game hunters residing in central and southern Wisconsin. This check indicated that 85,900 individuals used public hunting grounds. We sold, during that fall, 455,768 small game licenses, many of which were sold in areas not covered by the survey and to sportsmen who were primarily duck or forest game hunters. Thus, it is obvious that we have a tremendous use of our projects and a use which has probably increased percentage-wise since 1950.

Time restrictions for this paper will not permit a complete analysis of harvests, hunter-use days and the like. One season's incomplete check on 40 public hunting grounds in southern Wisconsin consisting of 128,500 acres will serve for purposes of illustration. During 1957, on these areas, game managers checked 7,351 hunters who had the following bag: 2,356 pheasants, 8 Hungarian partridge, 53 quail, 4 raccoon, 292 rabbits, 274 squirrels, 75 ducks, 20 geese, 11 fox and 2 woodcock; this is slightly less than one-half unit of game per individual.

That we have reached a point of some stability in the costs of running a lease program is illustrated by the following data; in 1944-45 costs on one 2,162-acre unit were 93 cents per acre; in 1946-47 the costs were 61 cents while the area had been expanded to 2,884 acres. In 1950-51, our first year of complete cost accounting, it cost 46 cents per acre to operate 110,409 acres of leased hunting grounds. During 1956-57 the costs for essentially the same areas had dropped to 43 cents per acre. These data include the 20 cents per acre lease cost and although it may appear that a management and administrative cost of 23 to 26 cents per acre is high, we feel that this is probably the minimum expenditure which can be made and still run a successful program.

2. *Purchase.* Horicon Marsh acquisition started almost ten years before the 1937 lease program. In the late 1920's the legislature recognized the wisdom of state ownership and restoration of this formerly tremendously productive area and appropriated funds for its purchase and development. Acquisition of Horicon faltered because of litigation and lack of funds and it was not until the 1940's that state ownership was largely completed.

During the intervening years the Fish and Wildlife Service was purchasing and blocking in the Upper Mississippi River and Horicon Marsh National Wildlife Refuges. Lands were also being bought by the Federal Resettlement Administration on the Meadow Valley Unit of the Central Wisconsin Conservation Area, and the Necedah area which later became a national refuge. The state, however, paid scant attention to purchase and even though the 1937 legislature passed the Voluntary Sportsmen's License Bill, initial emphasis was placed on leasing.

In 1943, the legislature passed another bill which earmarked 50 cents from the sale of each deer license for deer feeding and deer yard acquisition. Although this program had many short-comings, it did serve to focus attention on the tragic manner in which the deer herd was being managed. The deer yard acquisition program lasted about one decade. Many important deer wintering areas were purchased which also had high fishing and other forest game values. Today, deer yard acquisition is confined to purchases which provide blocking, access or preservation of high-value conifer cover. Emphasis is now placed on cooperative management and integration of forest management with game management on the vast acreages of public forest land. The values to deer and other woodland game are many times greater through this approach than through attempts to buy deer yards with game funds to be managed exclusively for wildlife.

Our leasing program has always emphasized provision of space for sportsmen. Likewise, our land purchase program has this objective, and in addition, the following goals:

1. To preserve an important American heritage of wild lands and wild things not only for hunting, but for all people interested in the outdoors.
2. To prevent draining, filling or destruction of wetlands.
3. To protect and manage wetland habitat for game.
4. To protect the important waterways in Wisconsin from improper land use.
5. To protect important fishing streams from the abuses of agricultural irrigation.
6. To prevent private blocking of important waterways, game lands and lakes.
7. To preserve and manage headwaters and springs which often form the biological base for a stream fishery.
8. To protect and improve spawning grounds for lake fisheries.
9. To protect a public investment in stream improvement work on lands presently leased by the department for a 20-year period.

Wetland purchase has received tremendous support in Wisconsin. Our systematic surveys of wetland losses have highlighted the problem. The best estimates indicate that more than 2½ million acres, *approximately one-half of the original wetland area,* have been affected by drainage. In 154 east central and southern Wisconsin townships, which have been surveyed, the losses are staggering. Briefly, there were 482,515 acres or 13 per cent of the land acreage in wetlands in these towns in the 1930's. Twenty years later 118,317 acres had been drained. Of the 364,198 acres remaining, almost 37 per cent or 134,557 acres are of a physical nature permitting drainage. Many of these acres are valuable wildlife habitat and in some counties these damp pockets of vegetation represent the last remaining *stable* wildlife cover. Unless state purchase or other programs block drainage, the eventual result will be a reduction from 13 per cent of the land area in marshes to six per cent. It is inconceivable that such loss would not have a tremendous effect on wildlife.

On the basis of the above data, our game acquisition program has concentrated in southern and east central Wisconsin. Likewise, fish management projects will be located in the same geographical regions. We do not mean to imply that there will be no acquisition in other parts of Wisconsin; however, the need is not as great for several reasons: less human population, less destruction of fish and game habitat, and more than 4 million acres of public forest land.

Expenditures for public hunting and fishing grounds purchases from 1937 to date total $2,517,021.00 on 177 approved projects. (These costs are for lands and improvements only.) We presently own 170,571 acres. That increased emphasis is being placed on purchase is demonstrated by the fact that from July 1, 1956 to July 1, 1959, $1,245,664.00 will be spent. In 1958 alone, 38 game or joint fish and game, and 33 fish projects have been approved by our Commission. Still remaining to be purchased on the approved projects are 165,000 acres which will cost between 5 and 5½ million dollars. On the basis of present budgets, it will take about ten years to complete this program.

Brief note should be made of the method by which the acquisition program is financed. The majority of the game and joint fish and game projects are Federal Aid to Fish and Wildlife Restoration projects. Because tax collections are much less under the Federal Aid to Fish Restoration Act, part of the fish management acquisition is financed with funds from general license sales. Generally, for federal aid projects, Voluntary Sportsmen's License revenue provides the backing money. To date, 94,000 acres costing 1.6 million dollars, gross, have been financed under P-R and D-J, which represents more than one-half of the total effort to date.

Initially, the department did not pay "taxes" on fish and game lands. In 1953, however, the legislature felt that acquisition was disrupting the tax base and provision was made for payment of school taxes out of conservation funds. Although areas purchased primarily for fishing were not included, the legislature is currently considering such an amendment. The cost of the school tax payment in 1957 was $16,347.00 on 81,119 acres for an average cost of 20 cents per acre. (Certain classes of game lands are excluded from this payment.) When the planned fish and game acquisition program is complete, the annual costs will probably total $65,000.00.

Management and maintenance of lease and purchase areas consists of patrolling during hunting seasons, posting of signs, regulation of car traffic, law enforcement, pheasant stocking and fire control. In addition, game and fish managers have a program of habitat improvement. Under the fisheries program, 20-year leases of land along navigable streams enable the department to put in capital improvements at department expense. On leased areas, game managers work with owners and encourage tree and shrub planting, winter feeding and purchase of small food patches. On purchased game and fish projects, and other public lands, management consists of all practical techniques to improve habitat.

During the 1956-58 period the following was accomplished on public lands: 197 food patches totaling 3,092 acres; 3,471 rods of fencing; 765 miles of legume and grass seedings along woodland trails; 44,018 acres of prescribed burning; 126 miles of firebreak construction; 6,981 acres of clearing; 50 miles of access road construction; 29 parking lots built; 414,480 feet of level ditching. In addition, 261 tons of feed were used for upland game and 4,827,573 trees and shrubs were planted; part of this effort was accomplished on public land.

These accomplishments cost approximately $1,250,000.00. Income from state wildlife lands during the same period was $94,765.00 which consisted primarily of sale of timber, surplus buildings, gravel, moss, hay, and muskrats and mink share-trapped at Horicon Marsh.

Cumulative project accomplishments on leased and owned fisheries projects through a ten-year period are as follows: 10,203 acres leased or owned on which 125 miles of waterway have been controlled through the planting of 1.8 million trees and shrubs, 150 miles of fencing, 6,945 channel and bank devices and 53,406 lineal feet of stabilization.

The following table summarizes the lands open to public hunting and fishing in Wisconsin:

TABLE 1. PUBLIC LANDS OPEN TO HUNTING AND FISHING IN WISCONSIN

	Acres
State-leased public hunting and fishing grounds	314,710
State-owned public hunting and fishing grounds	170,571
State forest lands	342,138
National forest lands	1,465,356
County forest crop lands[1]	2,185,580
Private forest crop lands[2]	353,616
State Land Commission lands	147,424
Sheboygan Marsh Public Hunting Grounds[3]	6,398
Horicon, Necedah and Upper Mississippi River Fish and Wildlife Refuges[4]	147,985
Grand Total	5,133,778

[1]Tax delinquent lands zoned and managed for forestry which receive state aids and which are open to public recreation.
[2]A state program designed to encourage forest management of private lands by tax benefits. These areas, although not posted, are open to sportsmen.
[3]A county-owned and managed area for public recreation.
[4]Open in part or completely during certain periods of the year and to certain species.

DISCUSSION AND CONCLUSIONS

An effort has been made to summarize the data and experiences of 20 years of operating a large-scale public hunting and fishing grounds program with the objective of providing other professional workers some guidelines for programs of a similar nature in other states. Out of these data can be drawn several generalizations.

First, provision must be made as in the case of our Voluntary Sportsmen's License and the Federal Aid Acts to provide continuity and a financial base for any program. Although earmarking of funds is not generally considered to be sound fiscal procedure, in our case it has been of tremendous value. Secondly, a sound program of land leasing must have as its basis, irrefutable data. Our surveys of hunter use, land posting, game harvests, stocking, residence of sportsmen, and costs, have time and time again been used to maintain the support and understanding of sportsmen and the public. Finally, game managers must be able to demonstrate that techniques of wildlife management are economically efficient and successful in terms of producing game.

We have come a long way in Wisconsin in 20 years on our program. New problems have developed which now need solution. For example, on our leased and owned areas it is obvious that if some semblance of "quality sport" is to be maintained that legal authority must be given to the department to regulate the numbers of hunters on any given area at any given time. We have, for example, lost top-notch public hunting grounds lessors simply because the sheer number of hunters on their farms on opening week ends is beyond their tolerance. Likewise, on some purchase areas elbow room is rapidly disappearing.

The cost of producing game farm pheasants which is now paid for by all small game hunters needs attention. It appears that a pheasant tag system may equitably distribute the cost of pheasant stocking on state areas to those who harvest the birds. Fee shooting should more properly be developed by private initiative.

When the department started a purchase program it was not necessary to make any payment in lieu of taxes. Local units of government, however, were successful in having legislation passed and the department now pays a "tax" equal to the cost of leasing lands. The long-range outlook, of course, indicates that this "tax" will increase. A thorough analysis of our data and a review of our experience would indicate that departments should act on this problem before state legislatures take action. In Wisconsin, for example, had we proposed that a portion of our income from state controlled land be allocated back to school districts in a manner similar to that used by public forest agencies, we would not be paying the amount of money now legally required. Our payments to any school district are not sufficiently great to make much difference to the school board members when drafting a budget; the psychology of a state payment is, however, extremely important and a practical political necessity.

Our "tax" payments now force us to make some very practical decisions on whether to lease or buy. Purchase to provide sportsmen with "space" is hardly justified when it can be leased for the same amount of money that we would pay in taxes each year. However, if we wish to preserve habitat or develop land for game, purchase will usually be the most practical solution.

A modification of the lease program which offers a partial solution to the above problem would be to establish a variable lease payment based on the quality of the land which we are leasing for wildlife. For example, we might pay an owner 50 cents for ungrazed marsh, 30 cents for grazed marsh, 10 cents for permanent pasture, etc. The total cost might not be much higher than a uniform payment, but it would condition the landowner to the fact that wildlife has a tangible economic value to him. In this age of excellent maps and aerial photographs, such a program would be easily accomplished administratively.

In the closing paragraphs of this paper, we would like to draw your attention to other programs. Our data, obviously, indicate that we cannot purchase or lease all wetlands in southern and east central Wisconsin, let alone the rest of the state. We do hope to strengthen the program by interspersing our large purchase projects with the purchase of scattered wetlands between major projects. One such program has already been initiated in western Wisconsin. Although purchase of scattered wetlands will help, our most intensive efforts in state controlled lands will be of little avail unless we exert some influence on private lands.

Stimulation of private initiative in the development of wildlife resources is one approach which Wisconsin has steadily promoted. We now have 375 muskrat farms under state supervision covering 48,000 wetland acres. These areas produce a wide variety of other game species. Although trespass is controlled by the owner, the public value of the game produced is evident.

In 1958 we licensed 37,500 acres of shooting preserves, on which 7,689 pheasants were released and 3,631 harvested. The birds which were shot provided recreation; habitat was preserved; some of the birds which drifted very likely ended up in the bag of the non-preserve hunter. Also, ten fee-shooting game farms of 1,545 acres and 14 membership game farms of 1,897 acres were licensed in 1958. Although we have no data on the man hours of recreation which these areas provide, it must be appreciable. Presently, legalized shooting of game-farm ducks is being considered by our legislature.

First steps are now being taken to use the zoning power of towns and counties to preserve wetland habitat. Game managers were instrumental in obtaining inter-agency endorsement of the use of zoning in wetlands conservation. Initial objectives include the zoning of established though incomplete state purchase projects. Because condemnation is not normally used to buy land, we rely on the fieldman's ability to negotiate. Through time, however, and without regulation, land-use changes make acquisition extremely difficult and practically impossible in some cases. Also, we hope to zone other wetland areas which under no circumstances should be drained for agriculture or developed for dumps, factories or homes. Such zoning would be in the interest of "public welfare." Finally, wetland zoning will hold areas in their present state until local units of government, conservation clubs, private groups or individuals purchase the zoned area for parks, conservation projects, public hunting and fishing grounds or development by the individual of wetland resources for profit. When economic pressures are sufficiently strong for any individual within a zoned area to show economic damages and no "general welfare" benefits, wetland zoning will probably not stand up in the courts; however, we hope that it will be one additional tool to be used by the game manager working with town and county governments.

A land purchase program of our size has resulted in conflicts in several cases with agricultural agencies. In part, the causes have simply been lack of communication between professional workers in agriculture and wildlife. We now are working more closely with all agencies having land-use responsibilities. Wetlands acquisition, for example, can have sharp conflicts with other economic interests and groups. To help resolve and minimize this problem we are working together to predetermine areas where wildlife interests will be paramount, where agricultural and other interests will be of top priority and where cooperative programs can be followed. During the past year game managers worked with the State Drainage Engineer, agricultural experts in muck land farming and soil scientists to prepare a model illustrating coordinated wetlands use. The model was on display at the Wisconsin State Fair, the Farm Progress Days held on our Yellowstone Wildlife Area, and the University of Wisconsin's Farm and Home Week. Thousands of people had the opportunity to see how coordinated conservation can be accomplished.

We are currently reviewing our day-old-chick program of cooperation with local clubs. In theory, they are pledged to release birds on unposted lands. As would be expected, our studies indicate that club members take a much larger share of the birds released than the non-club member. One hundred and eighty thousand 10-12-week-old pheasants should be sufficient inducement to stimulate formation of clubs and farm owners into cooperative associations covering large blocks of land. Although this technique does not permit public hunting in the normal sense of the word, it would provide large numbers of club members with hunting areas. One such association in Wisconsin, "The Better Friends Club," was organized and has functioned for 16 years. At one time landowners controlling more than 20,000 acres were in the association and some 1,350 guest and fee (50¢ to $1.50) hunters hunted on the unit in one season. Not only is trespass controlled with this program, but stocked pheasants can be hunted by large numbers of individuals. On the Better Friends area habitat improvement was also stimulated. Although the association concept has many possibilities, the chief obstacle is lack of continuity in local leadership of such programs. Our sportsmen's clubs have been held together and have continued their pheasant propagation program in cooperation with the state for more than 20 years. This, plus the fact that we now have game management personnel located all over Wisconsin who can direct clubs into farmer cooperatives, may be our solution to this problem.

We are proud of our Wisconsin Public Hunting and Fishing Grounds program. Through the first 20 years we have made tremendous progress. A solid foundation of public understanding and support will now enable us to improve and strengthen the program.

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DISCUSSION

DISCUSSION LEADER MACNAMARA: Most assuredly the public shooting ground has taken its place permanently, in the scheme of wildlife administration and, as you know, New Jersey has been one of the states where public shooting grounds have been used for 25 or more years.

In New Jersey on a Saturday you will find a large percentage—sometimes a very high percentage—of the same hunters who were there the Saturday before. I would like to know how you counteract that, if it occurs, and if it doesn't occur, do you think that it ever will?

MR. SMITH: Well, I am very sure we find the same thing in Wisconsin and to date we haven't done anything to counteract it. We are, of course, a long way from the population pressure which you feel in New Jersey.

MR. GLAZENER [Texas]: Mr. Smith, do you have in Wisconsin any restriction on out-of-state licensees, on these public hunting grounds?

MR. SMITH: Of course, they must have the regular non-resident hunting license, but there are no permits required on the public hunting grounds.

MR. EGBERT C. HADLEY [Chairman of the Board, Middlebury College, Middlebury, Vermont]: How long are the leases that you speak of? Some you spoke of are short-term leases. Have some been given up? Are some long-term leases?

MR. SMITH: Ordinarily when we first lease an area we take a one-year lease and, if the area is successful, we may take a five-year lease. Now, currently we operate on a lease of indeterminate length and, unless there is a change made either by the State or the landowner, the lease is continued.

MR. RAY HEADY [*Kansas City Star*]: With this vast acreage which you have available and some of the leases changing from year to year, how do you get to your sportsmen the exact boundaries for these public hunting areas so that they know exactly where and where not to hunt?

MR. SMITH: Every area we have under lease, of course, is posted and if the boundary changes during the year, we repost it. We also get out an instructional leaflet with the last map enclosed, which shows the general location of the area and how they can reach it.

MR. MCMAHON [State Conservation Service Department of New York]: On any of these leases that go five years or more do you do any construction of marsh lands?

MR. SMITH: No, sir. We do not. We do what we can to encourage the landowners to maintain good cover and we also distribute free trees and free shrubs in these areas. We are studying the possibility now of having a variable lease payment on those farms where habitat is maintained.

MR. MARTIN PENCE [Territory of Hawaii]: I want to know if you have a separate patrol of the public shooting grounds or a general patrol of hunting throughout the state.

MR. SMITH: No. They are a little more intensively patrolled but there is no separate patrol.

MR. PENCE: As a suggestion, in Hawaii the public shooting grounds are regulated separately from the rest of the public hunting or general territory, so that we are able to control the number of hunters during the season and the length of time during the day or any other factor within the Territory of Hawaii regulations. It makes for excellent management, in that you can manage each area on its own merits and you don't have any trouble of overcrowding or one man hogging the whole show. You can separate them by groups, alternating from day to day, so that the same man doesn't get all the gravy.

MR. SMITH: There is one control we do have. We have a blanket authority on the field level to establish closed areas in public hunting grounds. That is mainly around buildings but we also can close farmers' crops that are in danger of being damaged and use it for other purposes also.

DR. CHEATUM [New York]: We are beginning a program under our new Fish and Wildlife Management Act, where we are trying to work out with landowners a mutual agreement arrangement for contracts, to provide certain benefits to the landowners in exchange for allowing public hunting on certain portions of their lands.

We feel that one of the things which will probably be demanded by landowners in many areas in New York is protection from abuse and too heavy concentrations of hunters. After all, we have a very populous state and we have a real problem from the standpoint of hunting control and protective control. I was amazed at the low cost of operation per acre you recited presently on your public hunting grounds, 43 cents an acre, I believe, as of 1957. Is that correct?

MR. SMITH: That is correct.

DR. CHEATUM: Does that include the additional protective patrol which you indicated had been provided? Also does it include the cost of trees and shrubs and the cost of the pheasants themselves?

MR. SMITH: Yes. That includes all costs.

DISCUSSION LEADER MACNAMARA: One of the problems that are facing those of us who are acquiring public shooting grounds is taxes, and I wondered if anybody here has given much thought to that. I might add that in some of our discussions we feel that, inasmuch as our lands are productive of certain income—and sometimes it is quite considerable in regard to timber and minerals, gravel and so forth—that a percentage of this might go to the respective townships and counties in lieu of taxes and therefore take that burden from us. Certainly, as of now we don't pay taxes on the land, but the time is coming when we will and at the tax rate we have in New Jersey, it is going to be quite an item. That same thing might be true in other states. I would like to hear someone discuss that a bit, if they would.

MR. VESALL [Minnesota]: On grounds that we take off the tax rolls for public hunting grounds, we take 15 cents an acre in lieu of taxes, or 35 per cent of the Special Land Use receipts. That money goes back to the counties and is distributed through the school districts and townships, and so on, in the same manner as taxes. There are bills in the Legislature at the present time that propose raising that, in lieu of taxes, to 50 cents an acre; and there is another bill that proposes that we pay the exact tax rate on the land that was taken off the tax rolls, which, in some cases is as much as $2 or $3 an acre, so we do face a problem along those lines in Minnesota.

MR. GLAZENER [Texas]: Before I left the Game and Fish Commission, this question came up with regard to land acquisition areas. We explored the possibility of making some either flat-rate payment or percentage of revenues from hay and other income sources, and ran smack into a constitutional prohibition against the state paying taxes for any purpose on any of its holdings, so in that situation it will only be through a constitutional amendment submitted to the people that that payment can be made.

MR. SMITH: I might comment on Mr. MacNamara's statement. Perhaps in the future if we in Wisconsin could stabilize taxpayer payments with revenue coming from the land that we would be in a better position. I think that as our revenue stabilizes we may be able to study that.

MR. JOHN BRAINERD [Springfield College, Massachusetts]: Mr. Smith, we recognize your Department as a leader in conservation application. Have you found ways to use these public shooting areas in terms of conservation education? Will school youngsters take a part in habitat improvement?

MR. SMITH: This is already happening on many of our areas, particularly the ones we own. We have groups of students visiting the areas and sometimes carrying on continued projects, and as a matter fact we are in the process right now of developing a Commission policy to handle that very thing.

MR. KIMBALL [Colorado]: Will you please clarify what you mean by damage? You mentioned a figure of $600 annually. Is this damage by the hunter or by the wildlife?

MR. SMITH: It may be either. According to the law we are responsible for any damage that the landowner suffers as a result of the operation as a public hunting ground. Now, it may be that somebody cuts fences; or some hunter may shoot a cow—we have one such case. They shoot ducks. They do any number of things and that is the type of damage we deal with mainly.

TECHNICAL SESSIONS

Tuesday Morning—March 3

Chairman: VICTOR B. SCHEFFER
Biologist, U. S. Fish and Wildlife Service, Seattle, Washington

Discussion Leader: GORDON GUNTER
Director, Gulf Coast Research Laboratory, Ocean Springs, Mississippi

MARINE AND COASTAL RESOURCES

KODIAK BEAR-RED SALMON RELATIONSHIPS AT KARLUK LAKE, ALASKA

WEBSTER K. CLARK
Kodiak, Alaska

One can walk along almost any Alaska salmon stream in bear country during the summer spawning season and see jaws, heads, and other parts of salmon left by bears. At first glance the toll appears heavy, but careful check of salmon remains, along with observation of spawning salmon and fishing methods of bears, reveals a different picture.

Karluk Lake drainage on Kodiak Island is an important producing area for red salmon *Oncorhynchus nerka*. Here also lives one of the largest and most sought-after big game trophies, the Kodiak brown bear *Ursus arctos middendorffi*. In fact, the present world record is from this area. Bear and salmon have coexisted on Kodiak as long as anyone can remember, with the fish an important food of the great omnivore and scavenger. The true effect of bears on the salmon population has been conjectural. Shuman (1950) estimated that bears around Karluk Lake in 1947 destroyed salmon that would have had, at the cannery, a value of $117,649. Since 1952, an intensive effort has been made by Fish and Wildlife Service refuge personnel to learn some of the facts.

Under Regional Director Clarence Rhode the following have contributed: David Spencer (Refuge Supervisor); Paul Chapados, Russell Hoffman and Will Troyer (Refuge Managers); John Lutz, Kenneth Durley, Frank Toon, Frank Grogan, William Hines, Earl Fleming, and Webster K. Clark (Biologists and Assistants).

In this paper the writer, after five seasons (1952, 1954-57) at Karluk Lake, will attempt to evaluate the relationship between the valuable trophy mammal and the important commercial fish. Data have been collected by weir and stream studies, salmon tagging experiments, and general observation.

POPULATIONS

Both red salmon and bears were formerly much more numerous than at present. Now escapements are low and bears are intensively hunted in the drainage, primarily by nonresidents. Red salmon runs into the lake have been diminishing at an alarming rate. With intensive commercial fishing, annual escapements have decreased from over a million to less than 138,000 in 1956 (Table 1). Only since 1952 has there been a real attempt to census the bear population. This has been done while the mammals are concentrated near streams, and probably represents a seasonal rather than a permanent population. For the years 1952 to 1957 (Table 2) the average has been 116, or about one bear per 0.7 square mile in the approximate 80-mile drainage, surrounding the 12-mile long, 1-mile wide lake.

TABLE 1. RED SALMON ESCAPEMENTS AT KARLUK RIVER WEIRS FOR CERTAIN YEARS BETWEEN 1925 AND 1957[1]

Year	*Escapement*
1925	1,621,000
1926	2,533,000
1930	1,096,000
1935	877,000
1937	1,265,000
1938	1,076,000
1940	719,000
1945	658,860
1946	442,466
1947	484,749
1948	753,807
1949	690,390
1950	756,561
1951	672,922
1952	555,575
1953	734,465
1954	326,614
1955	385,719
1956	137,647
1957	220,675

[1]From files of Bureau of Commercial Fisheries, U. S. Fish and Wildlife Service, Kodiak, Alaska.

TABLE 2. BROWN BEARS AT KARLUK LAKE: ESTIMATED POPULATIONS IN SUMMER AND KNOWN KILL BY HUNTERS, 1952-1957

Year	*Population*	*Kill*
1952	124	19
1953	115	23
1954	132	19
1955	125	31
1956	117	17
1957	86[1]	13

[1]Probably conservative due to short census period.

The census is generally taken during July by two observers stationed on a commanding height, often overnight, who use high-power binoculars and spotting 'scopes to ascertain color, size, and other characteristics of the individual or group. All information is written down for each new sighting in an attempt to reduce duplication of count, especially when other areas are visited.

The easiest to differentiate is the mother-and-cub group, with its variety in numbers, age, absence or extent of nape mark, pelage color of the young and comparative size and color of the mother. The hardest is the lanky subadult single of common color and considerable mobility; usually the largest number seen during a lake-wide survey is accepted. Duplication in count is offset by unseen bears (especially small cubs) and wary night-feeders.

The following variables affect the accuracy of the census: (1) Intensity and direction of light, (2) pelage, whether wet or dry, (3) size perspective as a result of distance, weather and posture of bears, and (4) observer's experience and judgment.

VALUES

We all know the value of red salmon, though few of us realize the dollar value of the bear as a trophy. Each bear taken by a guided nonresident means at least $1,500 to the guide and his helpers, and to retail firms and transportation agencies of Alaska. Thus the revenue for 22 bears taken by nonresidents in the Karluk Lake area in 1955 represented more than $33,000; for 14 in 1956, $21,000. In addition, 9 bears were taken in 1955 and 3 in 1956 by residents, which added to the revenues of local merchants and airlines. Here we have income from an animal that costs nothing to raise. Since 1950 an estimated yearly total of $200,000 to $250,000 has been realized from legal kill of more than 150 bears in the Kodiak area. The world-famous bear also has great esthetic or amenity value.

The writer has also observed that bears do service in cleaning streams. When a small spawning stream is closed to visits by bears, it will generally soon become polluted with salmon carcasses. The writer noted this at Moraine and Halfway Creeks in 1952 after installation of an electric fence. Water is usually low during the spawning period, thus dead and dying fish tend to lodge against obstructions. Their carcasses are soon covered with fungus *Saprolegnia* sp. At the weir on Moraine Creek, 42.5 percent of a small run of pink salmon *Oncorhynchus gorbuscha* was found dead and unspawned, heavily infested with fungus. The extent to which heavy fungus infestation affects the eggs of red salmon already covered by gravel is not known. Should fungus cause egg destruction, then the bears do a service in removing carcasses from small streams. A creek to which bears do have access usually contains a few bits of carcass but is otherwise clean. At the mouth are other bits and whole carcasses, indicating material available for fertilizing the plankton of the lake.

SALMON SPAWNING HABITS

All species of Pacific salmon (genus *Oncorhynchus*) die after spawning once. After spawning, the fish is of value only as food for animals and as fertilizer. Therefore, spawned-out fish eaten by bears represent no real loss in the salmon reproductive cycle. Most red salmon spawn in the Karluk Lake drainage from early July to mid-November. There is usually a spawning peak in the last half of July and another during September. To a lesser degree, there is spawning during August. The chief difference between the two peaks is that rarely do any of the late spawners ascend the small tributaries used by about half of the early ones. The remaining half of the early ones and practically all of the late ones use the two large terminal systems —Thumb Creek and Canyon Creek-O'Malley Creek—as well as littoral areas. Scarcely one-third of the fish use the narrow shallow streams where, of course, chance of bear interference is considerably greater than in other areas of deeper waters and extensive escape territory.

BEAR FEEDING HABITS

Few bears are seen at streams when the first salmon ascend in July, as many are still grazing on upper slopes. Soon they become numerous. In fishing, the bear usually pins a salmon with one or both fore paws, then lowers its head to grasp the fish in its jaws and carries it to a gravel bar or into brush on a stream bank. A greater portion of each fish is eaten in early season than later, when fish become easier to take (less active and more numerous). Carcasses are also scavenged. At first, two or three salmon may satisfy the bear. Later, portions of a dozen or more may be utilized during a stream visit. Nearly always the hard parts of the head and jaws remain uneaten.

After the first week of August fewer bears are seen, apparently because of the competitive attraction of the ripening elderberry *Sambucus racemosus pubens*. Many salmon are still available in August. Occasionally bears are scarce by the end of July, as in 1953 and again in 1957. In each of these years the elderberries ripened early. One can quite safely predict that soon after green, but plump, elderberries are found in bear droppings, bears will be hard to find. In 1957, the ripening date was July 17, earliest on record; in 1956 it was July 29. Within about ten days, droppings contained little but elderberries. Elderberries are easily obtained and plentiful, and they predominate in the diet of the bear until the frosts of October. Bears—generally subadults and females with cubs—occasionally visit the larger stream- and lakeshore-spawning areas during this period. They fish less energetically than they did earlier in the season.

SALMON POPULATIONS OF THE SMALLER STREAMS

Since it is on the small tributaries that greatest predation by bears would logically occur, let us examine the red salmon populations using them. Salmon have developed traits of survival value with relation to bear—traits which help to explain how the fish populations have persisted through the years.

The first trait is common to all red salmon populations. Soon after the fish appear in the lake they congregate at the mouths of tributaries or in deep holes in larger ones. Here they mill about, while becoming ripe and red, in the safety of deep water.

As they reach ripeness and start to ascend the streams, another behavior pattern appears: mass exodus. When the first-ascending salmon are disturbed they tumble over each other to return to safety in the lake. When a small tributary is seen one day to be loaded with ascending fish and the next day practically empty, there is usually sign of recent bear activity, or in some cases, human interference. This escape behavior can be easily demonstrated by merely walking through the ascending salmon. They lose no time in returning to the lake.

As the season progresses, redds are hollowed, and when disturbed now the salmon move up or downstream only a short distance. At this time, a third and very important adaptation comes into play—the ability of the female to deposit eggs rapidly. The more widely wandering male seems to be able to eject milt for a somewhat longer period. To determine spawning speed, tagging experiments were conducted by Durley and the author in 1955 and 1956. Male and female salmon were seined and tagged while concentrated at the mouth of Halfway Creek; a few of the fish were ripe at this time.

After stream entry and redd establishment, several of the tagged salmon were caught by daily dipnetting and were examined to determine spawning condition. At this stream, redd establishment nearly coincided with stream entry, perhaps due to presence of a weir and human activity. The progress of spawning was ascertained by stroking both sides of the abdomen toward the anus to estimate ease of ejection and number of eggs ejected by females, and consistency of milt of the males. Also noted was overall thinness and freshness of the fish, speed of movement, and position in the stream, especially in relation to the redd. Netted specimens were released immediately. If unmolested, females were found devoid of eggs in 48 hours or less after establishing a redd. The milt of males became watery and diluted in a somewhat longer period. It was also discovered that a female, after spawning, stays in the vicinity of its redd as long as six days, even chasing other salmon from the area. After spawning, she is fresh-looking but thin, then gradually grows grayer and more fin-frayed. On about the sixth day she is no longer able to withstand the force of the current and she becomes a carcass lodged on a gravel bar, or washed into the lake. The male follows a similar pattern, though is more inclined to wander from redd to redd. He also attempts for several days to fertilize, even with well-thinned milt.

It is during the post-spawning period of as much as six days that the bears apparently make most of their catches. Fish become slower moving and of course easier to capture. Carcasses are also eaten. The short pre-spawning period of vulnerability is largely offset by the escape behavior and liveliness of the fresh fish. Due especially to the fast spawning adaptation, even the few fresh-looking individuals caught have usually fulfilled much of their reproductive role. As escapement diminishes, the number of partly-spawned females taken might become excessive, whereas, apparently, males able to fertilize eggs of more than one female would be of less importance.

ESTIMATED TAKE OF SALMON BY BEARS

When bears eat female salmon, often little remains but the hard parts of the head. In male remnants, the gonads are usually present. Therefore, on examination of bear-taken fish, more can be learned of the spawning condition of males at time of capture than of females. All bear-take studies at Karluk Lake using weirs started with those of R. F. Shuman and Philip R. Nelson in 1947 and 1948. A female was judged to be "spawned" if she had spent half or more of her eggs. Females with undamaged body cavity were fairly easy to judge, but often the actual condition of gonads of the males was more difficult to ascertain. Size, color of the gonads, consistency of the milt, and exterior appearance were considered. Much experience with spawning males was needed, though even two investigators might not agree on the same fish. The percentage of known-unspawned in total bear take is applied to fish of unknown condition, chiefly females, and the total unspawned in total carcasses examined is thus found. If the actual number of unspawned females were known, this number would be of more significance than the one used, which includes the more inconsequential males. Of some significance is the fact that a small percentage of natural dead salmon are found unspawned (Halfway Creek: 0.3 percent in 1948, 2.1 percent in 1955).

Weirs were operated on a typical small tributary, Halfway Creek, by refuge personnel in 1953, 1955, and 1956. In 1948 one was used here by Shuman and Nelson. The following results were obtained:

TABLE 3. BEAR TAKE AT HALFWAY CREEK

Year	Unspawned, percent	Total bear take	Carcasses examined	Escapement
1948	11.1	2517	6757	10,230
1953	1.5	127	3437	2,143[1]
1955	1.5	550	2147	2,845
1956	13.0	347	526	665

[1]Defective weir

The high percentage in 1956 was due partly to visits by bear to an escape pen, and loss of several unspawned fish which normally might have reached safety in the lake. Installation of an electric fence effectively stopped further visits. The low escapement that season also caused an increase in percentage.

Weirs were operated on Moraine Creek, another small tributary, by fisheries personnel in 1947 and 1948 and by refuge personnel in 1952 in conjunction with an electric fence which enclosed roughly the lower four-fifths of the spawning area (Table 4).

TABLE 4. BEAR TAKE AT MORAINE CREEK

Year	Unspawned percent	Total bear take	Carcasses examined	Escapement
1947	31.3	3,837	5,393	14,826
1948	26.3	10,232	18,484	61,160
1952[1]	20.4	1,077	1,472	10,962
1952[2]	00.6	235	9,407	10,962

[1]Outside fence
[2]Inside fence

Here is a range of unspawned bear-take from over 30 to less than one percent. Of course, the electric fence may have caused heavier use by bear of the unprotected upper area and less use in the remainder. The high figures for 1947 and 1948 may be related to a larger bear population in the first postwar years as a result of low hunting pressure.

At both creeks, bank and stream surveys were usually made as well as weir examinations. Carcasses checked at the weirs usually indicated a smaller unspawned bear-take than did those from upstream. The greatest variation was 35 percent outside the electric fence on Moraine Creek in 1952; 15 percent at the upper weir. Two probable reasons are: (1) bank and stream tallies usually contain a larger percentage of bear-taken carcasses, (2) natural-dying salmon tend to drift back to the lake. To arrive at the percentages in the above tables the stream and weir results were combined.

It is realized that there are various experimental limitations: (1) visits by biologists may reduce bear activity, (2) weirs and use of electric fence may reduce bear activity or weirs may in some instances increase bear damage by preventing return of salmon to protection of the lake, (3) spawning condition determination is difficult, especially in males. It is questionable whether unspawned percentage thus estimated should be applied to females of unknown condition. (4) bears may eat or mark salmon already dead of natural causes (carrion).

To date, these figures for unspawned bear-take can only be applied to the near 35 percent of total escapement in small tributaries. No estimates have been made on the larger systems or littoral spawning areas. One would expect them to be less in these more protected environments.

SUMMARY AND CONCLUSIONS

Both bear and red salmon, once more plentiful, are valuable wildlife resources and desperately need protection from over-exploitation.

Small tributaries of Karluk Lake are used almost solely by approximately one-half of the early spawners (or about one-third of total escapement). Bear interference is potentially greater on small streams than on the two larger systems and littoral areas.

Bears are numerous at spawning places soon after spawning begins. Their salmon feeding activity diminishes with ripening of the elderberry crop. Sporadic visits to spawning areas later in the season result in desultory fishing and scavenging.

Small tributary spawning populations apparently now suffer little loss of unspawned individuals to bear. These populations have escaped possible extermination due to the following adaptations: (1) they remain in the lake until ripe, (2) they move en masse from stream to lake when disturbed on first ascending, (3) the females, especially, spawn fast, and (4) fresh spawners are lively and elusive; spawned fish slower and more easily caught.

Due to the above factors, it would seem that few salmon taken by bear are entirely unspawned.

Tagging experiments on a small stream with weir indicated that stream entry and redd establishment are almost simultaneous, and that female salmon may remain in such a stream nearly a week after spawned out. At this time they are fresh-looking but thin. Therefore some fresh-looking bear-taken remains could be spawnouts.

Use of weirs on typical small tributaries to determine bear-take of "unspawned" (less than 50% spawned) salmon indicated little damage to present populations, although results varied from 31% (1947) to 1.5% (1955).

Salmon representing as much as 2.1% of the escapement may die naturally, unspawned. Bears often eat or mark carcasses.

By utilizing carcasses and so removing them from the stream, bears may help preserve runs by preventing fungus infestation, when other scavengers are not present.

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DISCUSSION

MR. MILTON TRAUTMAN [Columbus, Ohio]: In a movie Sunday evening, it showed a bear very adroitly grabbing salmon, holding them for a short time, and then dropping them. It appeared to me that it was dropping more males than females.

It that true?

MR. CLARK: It is not generally true, although, I am not sure about that particular bear. It might have been fussy, but to my knowledge, they do not seem to show much partiality. They prefer whichever is easier to get. They seem to like the skin about as well as any of the parts of the salmon.

MR. TRAUTMAN: Well, these bears seemed to be particularly fond of the eggs and seemed to feed on the eggs, first, and I was wondering if they could differentiate in some manner by scent or by shape of the head or something.

MR. CLARK: Oh, I should think so, and they may do that.

In my observation of them, I have not seen too much preference shown. They will not pass up eggs or females; I know that. Through experience, they can probably tell a female salmon from a male quite easily.

STUDIES ON STELLER SEA LION *(EUMETOPIAS JUBATA)* IN ALASKA[1]

OLE A. MATHISEN

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The production of salmon in Alaska has fallen from a pack of more than 7 million cases in 1935 to slightly less than 3 million cases in 1958. A large number of explanations have been offered for the mentioned decline. Basically the suggested causes fall into three categories: (1) overfishing, (2) change in productivity of the environment, and (3) predation by sea lions, seals, belugas, Dolly Varden trout, and other predators. Complaints have been made for a long time against marine mammals, particularly the sea lions. As far back as in 1899 plans were made for a large-scale killing of the sea lions in California as a result of petitions by the fishermen and the salmon industry (Smith, 1904).

In spite of the long history of the problem, no well-established basis exists today for relating the decline in the Alaska salmon fisheries directly to the predation by Steller sea lions. But since the mortality inflicted upon a declining stock of salmon by predators becomes progressively more important with increasingly smaller runs of fish, the volume of salmon taken by sea lions today deserves an earnest consideration. Any reduction of a source of natural mortality directly means increased commercial catches.

In 1953 the Fisheries Research Institute began a systematic study of the herds of Steller sea lions in Alaska to provide a factual basis for an evaluation of the predation of sea lions on salmon in this area.[2] The principal objectives of the study have been to determine the actual number of sea lions in Alaska, to provide data about their food habits, and to study those phases of their life history and behavior that pertain either to a control program of the herds or to a commercial utilization of the meat.

The problem of assessing the number of sea lions in Alaska is a difficult one, as the rookeries are spread out along 3,000 miles of coast line ranging from the Canadian border to Attu, the most westerly island in the Aleutian chain. Habitually the Steller sea lions seek the most inhospitable islands and cliffs for their breeding and hauling grounds. The majority of these places cannot be approached

[1]Contribution No. 52, College of Fisheries, University of Washington.

[2]The study on this project was first financed by the Alaska Salmon Industry and has been continued under contract to Bureau of Commercial Fisheries, U. S. Fish and Wildlife Service.

by boat except on calm days, which seldom occur. An accepted alternative to ground and boat surveys is aerial surveys. In 1947, rookeries in California were surveyed and photographed from planes and Navy blimps (Bonnot and Ripley, 1948).

The first systematic exploration of the use of aerial photographs for population estimates of the sea lions was developed by the Fisheries Research Institute during the years 1953 to 1955 and applied in 1956-1958. During our present-day census, a twin-engine amphibian plane, usually a Super Widgeon, is used to secure sufficient cruising speed and range to cover the large distances commonly met with in Alaska. A series of overlapping photographs of each rookery is taken during the middle of the day at 300 feet altitude while the plane is slowed down to a ground speed of 130-140 m.p.h. A suitable camera is a Leica M3 with a 90 millimeter lens. The film, either Tri-X or Plus X, is exposed at 1/1000-1/500 of a second. With longer exposure the pictures become blurred and unreadable. Prints of 8 by 10 inches are made so that overlap of the pictures can be determined before the actual counts of the photographed animals are made (Figure 1).

Surveys made at different times of the year from March through December consistently gave a maximum population count in May to

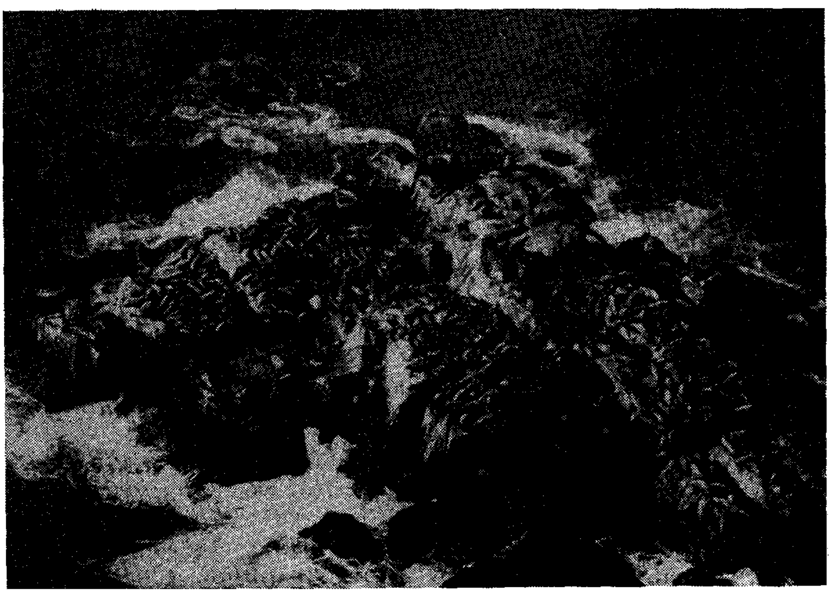

Figure 1. Sea lion rocks, Pye Islands, Kenai, May 29, 1957.

July, during the peak of the breeding season. In Table 1 the available summer counts have been entered, supplemented by counts from other areas, in order to arrive at a total population estimate of the Steller sea lions along the entire Pacific Coast. The indicated counts must inherently be minimum estimates of the actual total population, since the photo counts only give the number of animals present on a rookery at the time of a survey and do not take into account the animals, especially juvenile ones, which were at sea feeding during the survey.

TABLE 1. STELLER SEA LION CENSUS ALONG THE NORTH AMERICAN PACIFIC COAST

Location	Authority (time)	Total count
California	Commercial Fisheries Review, Vol. 21, No. 1: 1959	3,000 Est. (Total count of California Sea Lions and Steller Sea Lions 19,700)
Oregon	Kenyon & Scheffer (1953)	1,000
Washington	Kenyon & Scheffer (1953)	500
British Columbia	Pike (1958)	11,000-12,000
Alaska		
S. E. Alaska	Fish & Wildlife Service (unpublished)	4,000
Prince William Sound	Fisheries Research Institute (June 27, 1957)	8,180
Kodiak	Fisheries Research Institute (June 28, 1957)	35,770
Chignik	Fisheries Research Institute (May 28, 1957)	944
Shumagin	Fisheries Research Institute (June 30, 1957)	27,133
Bristol Bay	Fisheries Research Institute (Sept. 10, 1957)	147
Eastern Aleutians	Fisheries Research Institute (Sept. 30, 1957)	33,090[1]
Western Aleutians	Fisheries Research Institute North Pacific Tagging party estimate—1956-1958	40,000
	Total	165,264

[1]Minimum count. 1 . Akun and Billings Head not included.

The indicated total population of almost 170,000 animals is considerably higher than previously assumed (Kenyon and Scheffer, 1953) and may even at this be a low figure if a complete aerial survey is made of the western Aleutian Islands.

The largest portion of the sea lion population is found from Prince William Sound westward along the Aleutian Islands. The distribution of the major rookeries as we know it today is indicated in Figure 2, and these rookeries are all located in the migration path of major salmon runs in Alaska. The largest known rookery, on Ugamak Island, is strategically placed in Unimak Pass, through which many of the important red salmon races pass on their return migration to

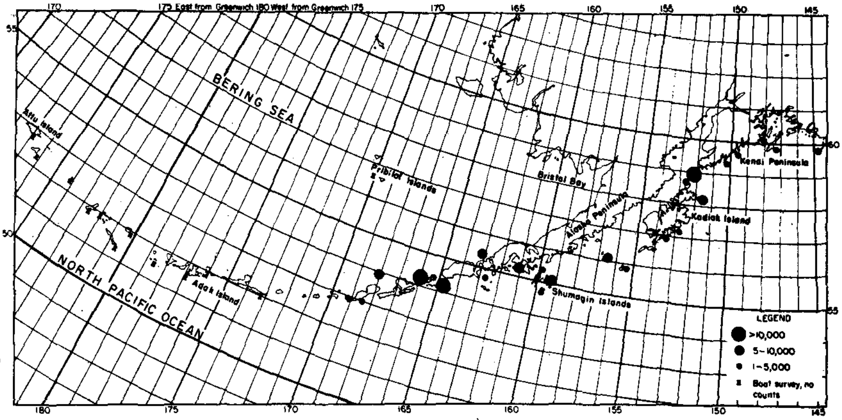

Figure 2. Distribution of major sea lion rookeries in central and western Alaska.

Bristol Bay. Clearly, such a distribution of rookeries in relation to salmon runs would be a rare matter of chance if no relationship existed.

During the last three years joint investigations by the United States and Japan have demonstrated that juvenile salmon, both of North-American and Asiatic origin, fed in the waters adjacent to the Aleutian Islands. Indications are that salmon probably is one of the most abundant groups of fish in these areas.

On the other hand, stomach sample analyses reported in the literature and recently summarized by Pike (1958) generally fail to show a high percentage occurrence of salmon or any other food fish. This was corroborated in 1958 when the Fisheries Research Institute undertook a three-month ground study of the sea lions on the Chernabura Island in the Shumagin area. A total of 114 adult sea lions was examined; the occurrence of food items is listed as follows:

Category	*Number of stomachs*
Fish (one salmon only)	42
Invertebrates	85
Kelp	2
Inorganic material (rocks and sand)	92
Unidentified (mostly fish remains)	24
Empty	20

Although fish were eaten in a large number of cases and contributed most to the food content in volume, only one salmon was found. However, it is doubtful whether the above results or similar studies give a true picture of the food habits of the sea lions. Samples taken on a rookery during the breeding season only reflect the food-take by mature animals during the period of reproduction with low food requirements. New evidence gained in the course of the high-seas tagging program by the Fisheries Research Institute points to a more persistent and intensive predation by both sea lions and fur seals.

In 1956-1958 a total of 36,223 salmon were captured with purse seine in sets made without any surface indication of salmon, contrary to the practice of setting around "jumpers" in coastal waters. Some sets were made up to 200 miles off the islands. In 601 sets made in 1956-1958 a total of 187 sea lions and 183 fur seals either entered the purse seine and attacked the fish or appeared next to the boats. The appearance of sea lions was always associated with the presence of salmon. No sea lions appeared when an empty haul was made. Of all the salmon caught, an average of 2.4 per cent were injured. In most cases the wounds were similar to those occasionally seen inflicted by sea lions inside the purse seine (Figure 3).

The injured fish captured in the purse seine only represent those which have escaped the attack and the percentage injury fails to give any indication of the actual number or percentage taken by sea lions or other mammals in the North Pacific Ocean. Furthermore, we are here dealing with a predation which takes place all year round.

Figure 3. Typical wound on a salmon inflicted by sea lions.

A simple calculation tends to show that the food requirements of the sea lions reach such proportion that if salmon only constituted 1/20 of their food, their take of salmon would equal the annual catch of salmon in Alaska exclusive of southeastern Alaska. The total catch of all species of salmon in this area in 1958 was equivalent to 137 million pounds.[3]

The Steller sea lion population in the mentioned area amounts to about 150,000 animals (Table 1). Based on the observed pup/adult ratio of 0.098 and a sex ratio of one bull for each two cows (Starks, 1918), the population in 1957 consisted of 45,500 bulls, 91,000 cows, and 13,000 pups.

Scheffer (1945) gives the weight of pups 6-10 weeks old as 87½ pounds. Kyte (1956) gives the weight of an average cow, 95 inches long, as 551 pounds, and by extrapolating his figures for weight of bulls, we can obtain an average weight for a bull of 120 inches in length as 1,591 pounds. We then can obtain the following calculations.

Weight of pups	:	13,000 x 87½ pounds................ 1,138,000	pounds
Weight of bulls	:	45,500 x 1,591 pounds...............72,391,000	pounds
Weight of cows	:	91,000 x 551 pounds...................50,150,000	pounds
		Total weight 123,679,000	pounds

The daily food requirement, based on 1/15 of body weight, as given for fur seals by Scheffer (1950), would amount to 8,245,000 pounds, and the yearly food requirement would total 3,009,425,000 pounds. This is 22 times the weight of all the salmon caught in central and western Alaska during 1958.

In regard to the damage inflicted upon the stocks of halibut in Alaska more factual knowledge exists. Questionnaires distributed by the International Pacific Halibut Commission indicate that the losses to sea lions are as high as one halibut to every four landed. This does not include indirect losses by damage to gear and interference with the fishing operations.[4]

Although the weight of evidence points toward a serious take of food fishes by the sea lions, it requires both long and extremely costly series of investigations to give a complete and quantitative picture of the food habits of the sea lions. An indirect solution of the problem may be to reduce the herds of sea lions by a commercial utilization of their meat and then observe what effect a decreased sea lion population has on the yield of salmon. Such a course of action depends upon

[3]Official records of the U. S. Fish and Wildlife Service.

[4]Preliminary statement issued at the annual meeting of the International Pacific Halibut Commission, January, 1959.

what markets exist or can be developed for the sea lion meat and what effective methods can be found for the harvest of these animals.

Currently the fur breeders in the Pacific Northwest, especially the mink ranchers, use more than one million pounds of whale meat imported from Canada or Japan. This spring experiments are under way to test the possibility of replacing whale meat by sea lion meat in the diet of the domesticated mink.

A commercial harvest of the sea lions or a control program can only be efficient and economical if the operations are planned to take advantage of the behavior patterns of these animals. Therefore, in 1958 the study of the general life history of the sea lions on Chernabura Island placed special emphasis on the reaction of the herd to stimuli normally associated with hunting. A summary of the data which are related to these questions follows.

The cows hauled to a suitable pupping area rather than being rounded up by a bull. The size of an individual harem did not remain fixed. A bull noted to have 30 cows one day might have only 10 cows the next day and possibly 35 cows the third day. Likewise, the number of idle bulls per harem was a changing figure.

No distinct courtship existed. The bulls constantly checked for cows in heat. Mating was observed during the period from May 31 to July 10 and took place shortly after birth of the pups. The first pup observed was born on May 25 and the last one observed took place on June 27.

The pups measured 35-40 inches in length and weighed 40-48 pounds at birth. In three to four weeks they were paddling about in the shallows and swam and dived. By the end of July some weighed 100 pounds and they were quite active, stayed near the water and fought when cornered.

During their first year of life the pups added 30 inches in length (Figure 4). Growth was greatly retarded or came to a standstill at the onset of sexual maturity, apparently in the third year of the females and in the fifth or sixth year of the males (Bonnot, 1951). More direct and positive means of determining the age of the sea lions are needed before the population dynamics, especially the rate of reproduction of the sea lions, can be determined.

During the height of the breeding season the harem bulls were extremely reluctant to leave their positions. The cow-pup association was so strong that a mother seldom abandoned her pup in spite of the presence of people and rifle fire.

During this phase of their lives the sea lions did not react to the presence of carcasses on the rookery. A killed harem bull was replaced within less than half an hour and frequently within ten minutes. If

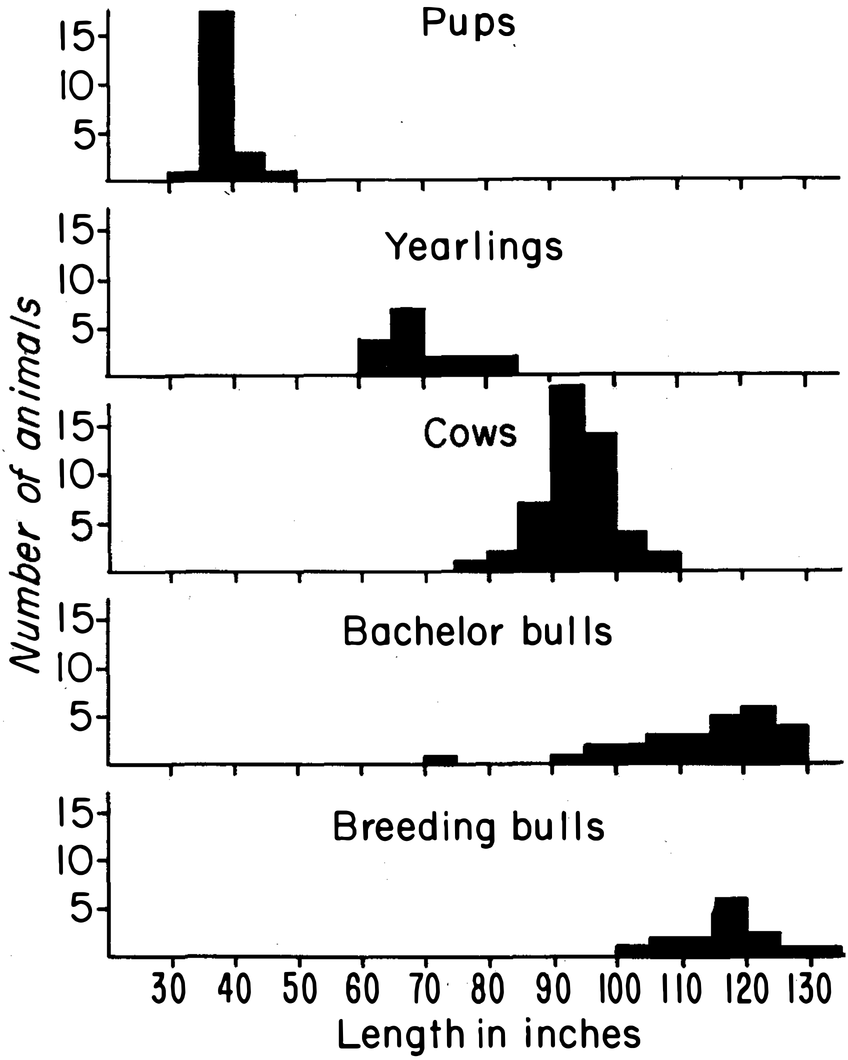

Figure 4. Length-frequency histogram of the different categorfies of sea lions, determined from measurements taken on all animals examined in 1958 on Chernabura Island.

pups were removed, new cows moved in rapidly with their offspring and utilized the free area.

At the end of July at a time when pups managed by themselves the harems dissolved and more persistent feeding commenced by all categories of animals, and the time spent away from the rookery increased. This was amply demonstrated by the aerial surveys which in fall showed a consistent decline from the summer population.

These facts clearly indicate that hunting of sea lions will meet with the greatest success during the height of the breeding season. This has been realized for a long time. Newcombe (1917, page 19) reports that an estimated 8,000 sea lions were killed in June in British Columbia by a few experienced hunters who systematically first killed the harem bulls and cows.

At all other times of the year the wariness of the animals to the presence of people and shooting is greatly increased and the first shot fired on a rookery usually results in a mass exodus from the rookery.

If the only object is a reduction of the sea lions in a district, shooting can take place at a great many rookeries. If a commercial utilization of the meat is intended, the animals must be felled in places where they can be retrieved easily. If sea lions are shot in the water they immediately sink. The topography of many rookeries is so rugged as to prevent any economical retrieval of the animals. Sugarloaf in the Barren Island group with a population in excess of 10,000 animals may serve as an example. In spite of its proximity to Kodiak Island and cold storage plants there, this rookery will probably always serve as a sanctuary for the animals as far as commercial operations are concerned. The same remarks can be made for many other large inaccessible rookeries or numerous small ones which cannot support an economic harvest of these animals. In the foreseeable future there appears to be no danger of exterminating the sea lions through a commercial utilization program. The cost of organizing a hunting expedition and the small price commanded by sea lion meat, about ten cents per pound, will always prevent the herds from being reduced to the point of extermination.

Appreciation and acknowledgment are expressed to Dr. W. F. Thompson, Director of the Fisheries Research Institute until 1958. In 1953 he initiated the studies here reported as a link in a comprehensive study of the salmon problems in Alaska, and he personally developed the photographic census technique employed by Mr. Ron Lopp during the surveys in 1956-1958. Mr. Robert T. Baade was in charge of the life history studies at Chernabura Island in 1958, and Mr. Allan Hartt, in charge of the North Pacific tagging studies, furnished data regarding injured fish.

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DISCUSSION

MR. JAMES BROOKS [Alaska Department of Fish and Game]: It seems to me that Dr. Mathisen's method of figuring tends to magnify the extent of salmon losses due to predation by sea lions.

The estimate figure which he credits as originating with Dr. Scheffer, that is, that 15 per cent of the animal's body weight is taken in each day as food. We, in the Department of Fish and Game, have done some collecting of sea lions, and 15 per cent would be the extreme amount in our opinion that a sea lion would take; and on a daily basis, over a long period of time, we doubt seriously that the sea lions would take that much food.

In arriving at your estimate of the salmon loss, you assume that all of the 150,000 sea lions in central and western Alaska were utilizing food at the rate of 15 per cent of their body weight per day.

Certainly not all of these sea lions are in areas where salmon are found. I assume that you have made allowances for young animals which are still nursing and would not take the amount of fish one would otherwise propose. You also assume that 20 per cent of the food intake of all of these sea lions is salmon. That, in my opinion, is an exaggeration and more than a minor exaggeration.

All of this does confirm, in my view, that you are magnifying the extent of the problem, and at this time, that might be a serious mistake. We have, in Alaska, numerous commercial fishermen who are at this time pressuring for a bounty system on sea lions. It isn't the first time that such a thing has been suggested.

The Fish and Wildlife Service itself has been plagued with similar requests, and I feel it is dangerous to err on the side that Dr. Mathisen has today, if he has erred. It is my opinion that he has.

CHAIRMAN SCHEFFER: Thank you, Jim. We know your reputation in Alaska and your long experience with marine mammal studies and as I say, we are glad to have those comments for the record.

Would you like to reply?

DR. MATHISEN: First, I would like to stress that I did not say that 1/20th of the food of sea lions consists of salmon. What I tried to indicate is that the magnitude of the food requirements of sea lions are staggering, and, furthermore, salmon are the most abundant fish in the waters adjacent to the Aleutian Islands where the greatest concentrations of sea lions are found.

So what I would like to say again is that there exists a possibility that the take may be a great one, but we do not know exactly what the food requirements are or what the sea lions actually take, and for that reason, the Institute can see no justification for a reduction, for introduction of a bounty system or a pure control program of the sea lion herds.

What we are trying to advocate is the utilization of a large potential source of protein which today is not used at all. If we can find some means to utilize part of the sea lion herd, we may gain some experience in determining what their relationship to salmon is, to what extent salmon enters their diet.

Obviously, the sea lion cannot be strongly dependent on salmon because, as you know, the salmon fisheries are subject to great annual fluctuations, while the sea lion, with a long life span, has a fairly stable population level, so a close relationship cannot exist, because otherwise the sea lion would fluctuate in relation to the annual cycle of the salmon runs.

MR. BROOKS: Dr. Mathisen, I am sorry if I misunderstood you with regard to the percentage of salmon that you estimated would enter in the diet in the sea lion.

However, I would like to point out, and I am quite sure that you are well aware of it, that sea lions are attracted to fishing vessels, and the fact that you found, this small percentage of salmon marked by sea lions, may not justify, projecting such a loss over a wide area. That situation, perhaps, may have been very localized right around the boat.

ON THE POSSIBILITIES OF IMPROVING SALMON SPAWNING AREAS[1]

WILLIAM F. ROYCE

Fisheries Research Institute, University of Washington, Seattle

In the salmon's life from egg to spawning adult there are many hazards, but far and away the greatest mortality occurs during the egg and larval stages in the gravel. On the average in Alaska and British Columbia less than 10 per cent of the eggs of pink, chum and red salmon hatch and leave the gravel as free-swimming fry.

Here is an anomaly. The salmon bury the eggs in gravel to protect them—indeed they are protected more than the eggs of most other fish. They are hidden from predators—nothing molests them. Apparently they are secure within their rocky walls. Yet 90 per cent of them die.

Here also is hope. This is the time in the life of salmon when we can reach them, and provide for them if we know what they need. Far greater are the possibilities for help at this time than later in the lakes and in the sea. Then they must be on their own.

Of course we have been attempting to protect them for many years by removing them completely to hatcheries. Here they are hatched and then released as fry or reared to a larger size and released as fingerlings. Yet something has been lacking in our technique because

[1]Contribution No. 49, College of Fisheries, University of Washington.

the returns from hatcheries have averaged no better than the returns from natural spawning. The hatcheries are a necessary substitute for natural spawning areas, but they have not been a satisfactory supplement where natural spawning areas are accessible. No substantial salmon run has yet been created or maintained by hatcheries.

What, then, is the answer to the urgent need for improving salmon runs that have ready access to their spawning grounds. Clearly the place to start is with the 90 per cent mortality while in the gravel. There is every reason to expect that any increase in survival to the fry stage will be followed by a corresponding increase in the average returns of adults.

It is the purpose of this paper to examine some of the literature on salmon spawning grounds and to suggest an answer.

SUCCESS OF NATURAL SPAWNING HIGHLY VARIABLE

The poor success of much natural salmon spawning in Alaska, British Columbia, and elsewhere has been clearly documented. Foerster (1938) investigated the red salmon at Cultus Lake and found the natural survival from egg to migrating fingerling varied from 1.05 to 3.23 per cent. This compared to a survival to fingerlings from eggs which were hatched in the Cultus Lake hatchery of 0.96 to 3.90 per cent. The Fisheries Research Board of Canada (1956) reported several observations on the survival of red salmon from egg to fry. At Port John the annual survival during seven years ranged from 1.8 to 25 per cent. In Williams Creek off Lakelse Lake survival was 7.8 per cent in 1954 and 17.7 per cent in 1955. In Scully Creek off the same lake the survival during six years varied from 9.3 to 13.8 per cent. Wales and Coots (1955) found survival of king salmon from egg to fry stage varied from 7 to 32 per cent in Fall Creek in California during the four years of investigation. Hunter (1948) reported that at Port John, B. C., the survival over one winter was 0.87 per cent for pinks and 0.99 per cent for chums. Pritchard (1947) reported that pink salmon in Morrison Creek, B. C., survived to the fry stage during two years at the rates of 4.7 and 6.7 per cent. He also reported that chum salmon in Nile Creek, B. C., survived to the fry stage at the rate of 3.0 per cent. Neave (1953) reported that the pink salmon survival rate from egg to fry during their fresh-water life varied from 1 to 24 per cent, and concluded that the principal cause of fluctuation in the populations of this species was due to the fresh-water mortality. The records which have been kept at the Little Port Walter Alaska station of the Bureau of Commercial Fisheries since 1940 (Myren, 1956) have shown that survival of pink salmon from egg to fry in Sashin Creek has varied one hundredfold from 0.2 to 20 per cent with an average of only 2.4 per cent.

On the other hand, natural spawning of salmonids can be very successful. Pritchard (1947), who reviewed the work of several Canadian colleagues, reported that silvers in Oliver Creek, B. C., survived from egg to fry stage at rates from 11.8 to 30.4 per cent and 16.3 to 40.1 per cent in Beadnell Creek. Briggs (1953), who sampled the redds of silvers, kings, and steelhead in California, found survival averaged 86 per cent for kings, 74.3 per cent for silvers, and 64.0 per cent for steelheads. Hobbs (1948), who reported on an examination of 711 redds of brown and rainbow trout and king salmon, estimated average survival at 91.4 per cent to the fry stage in the New Zealand rivers which he studied.

The results of a spectacularly successful natural spawning appeared in 1958 in the returns of nearly 20 million red salmon to the Fraser River. Almost all of these came from the Adams River tributary in which about 2 million parents spawned in 305 acres.

SOME LIMITING FACTORS ARE KNOWN

Many of those who have examined natural redds and others who have made special studies have identified specifically some of the factors which limit survival. They may be classified as follows:

1. *Access.* It is, of course, obvious that salmon must be able to reach the spawning grounds, but there has been a great deal of dispute about the effect of partial blocks in the rivers. We do not propose to review this extensive problem here, but merely to report that the current opinion is that any delays in reaching the spawning areas may result in a lowered efficiency of spawning and quite commonly the retention of some of the eggs by the females.

2. *Freedom from disturbance.* The eggs, once deposited in the gravel, are seldom disturbed by things other than floods or later spawners. Floods, of course, can be devastating. Hobbs (1937) believed that floods were responsible for very low survival of certain year classes of trout in New Zealand. Gangmark and Broad (1955 and 1956) tried to increase the survival of eggs in Mill Creek, California, where the bottom "was very erosive" by planting the eggs in Vibert boxes and in plastic sacks. Even when the eggs were thus protected, the results were very variable due to the floods.

The effect of successive waves of spawning on the earlier spawn is not known although it is suspected of being damaging. It is commonly supposed that late-spawning chums will seriously affect the earlier-spawning pinks, but the supposition seems to be contradicted by some evidence that when chum survival is good, pink survival is also good.

3. *Other animals.* The only animals that appear to be seriously

detrimental to salmonid eggs and larvae are some of the free-living worms. Briggs (1953) reported that steelhead redds infested with oligochaete worms suffered much higher mortality than the redds without such worms. Shapovalov and Taft (1954) mentioned that it may be desirable to control these worms. I have observed personally that pink salmon spawning areas in Alaska are occasionally infested with oligochaetes. Robert L. Burgner in a personal communication reports that *Planaria,* oligochaetes, and insect larvae are common in the red salmon spawning gravels in the Nushagak system of Bristol Bay. Theodore R. Merrill of the Bureau of Commercial Fisheries in Juneau in a personal communication mentioned that he has found *Planaria* in the red salmon spawning areas of Brooks River, but does not know their effect on salmon. Gammarids have been found in redds and suspected of being harmful, but Vibert (1956b) concluded that they ate dead eggs and thus might be beneficial.

Other fishes have commonly been accused of eating eggs, but careful investigations have revealed that they appeared to eat only those eggs which remain unburied after spawning. Greeley (1932) reached this conclusion and decided that the eggs in the gravel were well protected from all vertebrate predators. Other authors who have investigated the problem agree.

4. *Disease.* A number of diseases are known to kill eggs and larvae in hatcheries, but the prevalence of these in nature is virtually unknown. Infection of the fungus *Saprolegnia* has been reported in redds, but Hobbs (1937) concluded that the fungus grew first on eggs which had died from other causes and later killed other eggs.

5. *Lack of Fertilization.* Hazzard (1932), Hobbs (1937), and Cameron (1940) all concluded that salmonid eggs were usually fertilized very efficiently. No clear evidence to the contrary has been produced despite the claims of some of the early fish culturists, but it should be noted that certain fisheries might take such a preponderance of males through the use of selective gear that some eggs would remain unfertilized. This is unlikely, for Mathisen (1955) found that red salmon penned with a ratio of 15 females to one male produced only slightly more unfertilized eggs than a natural population.

6. *Lack of Suitable Water.* Without question, the character of the water that flows around the eggs and larvae in the spawning gravel is the most important factor in their survival. The water must contain no deleterious chemicals, it must be of a suitable temperature, and it must have adequate oxygen. It must also carry away waste products, but when adequate oxygen is available, the water flow will be more than adequate to carry away the wastes.

The water within the gravel must be from one of two sources—

either the flowing water above the gravel or ground water from a more distant source. Ground water appears to be the usual supply to spawning areas of red salmon along lake shores. In some streams, also, ground water is important. For example, Pick Creek, a tributary of Lake Nerka, Alaska, contains a large run of red salmon that spawn directly in the spring holes.

However, it would appear that the great majority of salmon that spawn in streams do so in places where the only source of water around the eggs and larvae is from the flowing water above the gravel. Chambers *et al.* (1955), who examined the spawning areas of king, red, and silver salmon in 26 streams in the state of Washington, report, "Definite evidence of upwelling of subterranean water was encountered in only one stream. Since successful spawning occurred in the other streams, upwelling was not an essential factor in the spawning area." Similar observations have been made in the pink and chum salmon streams in southeastern Alaska, by the Fisheries Research Institute. Here, ground water has been found in only one of several study areas and it is harmful because it is completely lacking in oxygen. Thus it is clear that the first requirement for the vast majority of salmonids is the quality of the water flowing above the gravel, and secondly, how well that water penetrates to the level of the eggs and larvae.

Harmful chemicals in the water appear to be a factor only where pollution is occurring. This factor is becoming increasingly important near cities and towns, but in the vast majority of salmon streams of Alaska no pollution whatsoever is occurring.

Saltwater in concentrations below about 2 per cent salt is not harmful and may be desirable. Rockwell (1956) found that pink and chum salmon eggs and larvae survived better and grew faster in mild concentrations of sea water than they did in fresh water. He found also that the benefits of sea water were greater at lower temperatures.

Suitable temperatures, neither too hot nor too cold, are necessary. Most salmonid eggs suffer when the temperature rises above 55°F. or falls below 35°F. However, the tolerance of later stages in the gravel falls to nearly 32°F. for many of the species. Robert L. Burgner reports in a personal communication that in Lake Nerka, Alaska, red salmon eggs and larvae apparently have a considerable tolerance for temperatures near 32°F. In the state of Washington, Chambers *et al.* (1955) report that spring chinooks spawned on a rising temperature which varied between 40° and 51°F., fall chinook spawned while the temperature was dropping from 56° to 41°F. Steelhead and trout spawned in the temperature range 38° to 48°F. They had reported previously (1954) that sockeye spawned in water temperatures between 51° to 54°F. and silvers 40° to 48°F. The International Pacific Salmon Fisheries Commission (1951) reports that sockeye spawning in the Fraser River almost always takes place at water temperatures between 45° and 55°F. They consider that poor survival has occurred when spawning has happened at temperatures near 60°F. and below 45°F.

Because Pacific salmon generally spawn successfully in a wide variety of streams from California to the Arctic Ocean, it would appear that the species are relatively tolerant of different temperatures and that the individual races have developed habits of spawning and periods of life in the gravel suited to the temperature regimes of the streams.

I believe that the most common hazard to the eggs and larvae is the shortage of oxygen caused by a lack of adequate flow through the gravel. Hobbs (1937), who studied brown trout, king salmon, and rainbow trout in New Zealand streams, found that survival of eggs and fry was poorest in the dirtiest redds. Shapovalov and Taft (1954) thought that silting was probably the principal cause of low survival in the spawning areas of steelhead, rainbow trout, and silver salmon of California. Wickett (1954), who developed methods of sampling the water and gravel found that high mortality of chum eggs was due to low oxygen levels associated with the slow flow of water through the gravel. Chambers *et al.* (1955), who examined the redds of many spawning salmon in Washington, report "The dissolved oxygen content of surface water was consistently higher than that of the subterranean water. . . . The dissolved oxygen content of the subterranean water flowing around the eggs varied from 5.70 to 9.10 p.p.m. in chinook; 1.90 to 7.85 p.p.m. in silver; and 1.40 to 7.25 p.p.m. in sockeye redds." These lower values will be fatal to salmon eggs at certain stages.

Similar results have been obtained in studies of the streams in southeastern Alaska by the Fisheries Research Institute. Our data on sub-surface flow, ground water, sedimentation, permeability of the gravel, etc. indicate that water circulation and oxygen level in the gravel are the keys to the survival during the winter of pink and chum salmon eggs and larvae.

METHODS OF INCREASING WATER CIRCULATION THROUGH THE GRAVEL

The amount of water circulating from the flowing stream down through the gravel can be increased only by increasing the water in the flowing stream, or by reducing the compaction of the gravel or the amount of fine material in the gravel. The compaction and amount of fine material are reduced naturally during freshets when the water reaches a high enough velocity to carry the stream bottom along with it—if the freshet does not bring more silt from the land. The finer materials are retained in suspension the longest and many of them will be washed on out to sea in the relatively short spawning streams that are typical of Alaska.

The other way in which the fine materials are removed is through the spawning activities of the salmon themselves. During the normal construction of the redds, a large amount of gravel is moved, and the fine materials are washed out and on down stream. Chambers *et al.* (1955) report "Construction of the redds increased the flow of more highly oxygenated water through the gravel where the eggs were deposited." Certainly, it is a common observation that when large runs of salmon use a limited spawning area, gravel is thoroughly worked over by the spawning fish throughout the area.

This activity of the fish may well be a factor in more successful reproduction of large runs. It is probable that in many of the relatively slow-moving streams that are characteristic of pink and chum salmon areas of Alaska that the gravel will not be cleaned adequately in the slower parts of the river unless large numbers of salmon participate.

The gravel, once cleaned of its fine materials, may retain its porosity for considerable periods. Wickett (1954) washed a consolidated area and found that it maintained a high saturation value of oxygen for a year. In a heavily silted area, similar washing produced a noticeable increase in the within-gravel flow, which lasted for ten weeks. In some preliminary studies by the Fisheries Research Institute in pink salmon streams near Hollis, Alaska, it has been found necessary to remove only a small proportion of the fine material in order to increase the flow materially.

EGG PLANTING FREQUENTLY SUCCESSFUL

The earliest fish culturists who wanted to transfer salmonid eggs from one stream to another first considered planting the eggs in gravel either in boxes or merely in trenches. Fry (1854) reprints an article by Gehin who describes a small hatching box which was designed to receive ova and then be buried in the gravel. Fry also mentions the practice of digging trenches to receive the eggs. Many others, including Harrison (1923), Foerster (1934), Robertson (1937), Shapovalov (1937), Shapovalov and Berrian (1940), Carl (1940) have reported on experiments with hatching eggs in gravel with greater or lesser success. Commonly they have compared hatching eggs in gravel with hatching them in troughs and found that the eggs in gravel hatched less successfully. Most thought that the deaths that did occur were due to poor circulation of the water through the gravel or to handling of eggs during the experiments. Neave and Wickett (1955) report on planting 2,606,000 pink eggs in Jones Creek, a tributary of the Fraser River. They found that 42 per cent of these eggs emerged as fry. Vibert (1949) advocates the use of his small plastic box in which he buries trout eggs in the gravel. He reports generally excellent results. In 1956(a), Vibert reported that eggs hatched under gravel produced fry that were 15 per cent heavier, suffered less from bluesac disease and later were more vigorous fingerlings. The International Pacific Salmon Fisheries Commission (1957) reports that transplants of eyed eggs in 1950 into the gravel of upper Adams River and Portage Creek had both produced returns of adults. In spite of the variable success of egg planting, many authors have recognized that the fry which emerge naturally from the gravel probably have a much better chance for survival than hatchery fry that are released into the stream or lake.

ARTIFICIAL SPAWNING AREAS SUGGESTED

A number of people have created artificial spawning areas and observed the use of them by salmonids. White (1942) tried some artificial spawning beds for Atlantic salmon and found that they were promptly used. He advocated them as a means of extending the area for successful natural spawning. Hourston and MacKinnon (1957) report on the first experiments with an artificial spawning area in Jones Creek, British Columbia, which was built to replace an area lost due to hydroelectric development. They report a survival to fry from the 1946 spawning of 37 per cent of the pinks and 30 per cent of the chums. Later they had trouble with silt deposits in their artificial channel. Prevost (1957) reported that lake trout used a railroad fill for spawning more successfully apparently than other natural spawning areas. The Washington State Department of Fisheries has been experimenting with a substitute spawning beach for Baker Lake sockeye salmon (Quistorff, 1958). The first attempt to develop an artificial spawning area in a tributary was unsuccessful apparently because of silting due to winter floods. A second attempt was made to produce an artificial spawning area in a large concrete tank and here survival of the eggs was good. Another artificial spawning channel has been constructed near McNary Dam on the Columbia River but no published data on its success are available.

Neave and Foerster (1955), who suggest artificial spawning areas in their discussion of problems of Pacific salmon management, point out that theoretically all the pink or chum salmon eggs in British Columbia could be incubated in areas totaling one square mile. Certainly on the basis of present experience with fish spawning naturally in gravel it is theoretically possible to produce several million living fry per acre. For example, the International Pacific Salmon Fisheries Commission reported that they induced red salmon to spawn in an area with 11 square feet per female. They estimated 3,700 eggs per female and found an average success of egg deposition of 67 per cent. This is a production rate of 9,650,000 per acre!

RESEARCH IS NEEDED

The people who have tried planting eggs and who have created artificial spawning areas have recognized the need to improve the survival of the salmonid fishes during their vulnerable period. They have attacked the problem directly and with some success in spite of the fact that very little is known of the biological and physical factors involved. We need urgently to know more of the ecology of the things that live in the gravel: the salmon eggs and larvae, of course, but also the diatoms, bacteria, and invertebrates that are associated. Equally urgent is the need for knowledge of stream flow, stream gradient, gravel porosity, gravel size, and all of the inter-relationships which determine whether the final resting place of the eggs is favorable. Clearly, we must direct research at the more basic problems if we are to provide our engineers with specifications for artificial spawning areas or ask them to improve the natural spawning areas in a stream.

Such research should show us easy ways to improve salmon runs because this is the stage of the salmon's life that is readily accessible to us. We know that a very large proportion of the eggs and larvae die in the gravel and that most of this mortality is associated with low water flow caused by silting and consolidation of the fine materials in the gravel. We know also that a relatively small area of ideal spawning conditions can produce very large numbers of living fry.

Thus it should be wholly practical to create or improve salmon spawning areas at moderate cost if we know what the salmon need. We should be able to develop many spawning areas as good as the 305 natural acres in the Adams River that produced $25,000,000 for Canadian and American fishermen in 1958.

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STATUS AND MANAGEMENT OF THE POLAR BEAR AND PACIFIC WALRUS

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The polar bear and Pacific walrus are both marine mammals of the Arctic. In waters contiguous to the United States, they are found only in and adjacent to Alaska. Until the arrival of the white man in the far north, neither species was killed in substantial numbers. The extension of whaling into the Bering Sea and Arctic Ocean in the mid-19th century initiated a decline in the Pacific walrus population that has continued, with some changes in tempo and for a variety of causes, to the present day. The exploitation of the polar bear adjacent to Alaska has been a continuing process throughout the span of recorded history. The recently devised method of hunting polar bears with the aid of small aircraft has led to an increased kill of polar bears as trophies by white hunters. This kill by "sport" hunters has aroused concern for the welfare of the species.

POLAR BEAR

The polar bear is circumpolar in distribution, spending much of its time on the broken pack ice of the Arctic Ocean. Since this floating habitat circulates with ocean currents, the bear population can be presumed to move in much the same fashion, with some modification by active movements in pursuit of food, and northward movements in the spring as the habitat melts at its southern edge. The bear population is probably concentrated around the periphery of the Arctic Basin, although there are records from nearly as far north as the pole. For example, a polar bear female with one cub became tangled in the wires of the runway lights on Drifting Station "Alpha" on December 20, 1957, when the station was located approximately 84° North latitude. (Incidentally, the bear broke the wire and turned off the runway lights just as an aircraft was about to land.) Where lack of tides and currents permits more or less solid freezing of the sea, bears are scarcer than in areas with stronger currents and more open leads. Pedersen (1945), Laughry (1956), and Heptner (MS) provide more detailed data on distribution of the bear, and Pedersen's publication contains the most extensive account of its biology.

Alaska

Until 1957, there was little detailed information on the polar bear in Alaska. At that time, under Federal Aid in Wildlife Restoration Project Alaska W3R, Paul E. Tovey began field work under the direction of Robert F. Scott. The results of the first year's work were presented to the Eighth Alaska Science Conference (Tovey and Scott, 1957). Field work was continued during 1958 by Sigurd T. Olson. The data in Table 1 are summarized from their findings.

Of the bears taken by whites, all were taken with the use of aircraft except five in 1957 and three in 1958. It may be of interest that two bears were killed in 1958 by the use of bow and arrow. The preponderance of male bears in the harvest is at least partly caused by selectivity of trophy hunters who are looking for the largest bears.

As a possible index to the status of the bear population adjacent to Alaska, pilots and guides hunting bears from the air were asked to report bears seen and the number of flying hours spent hunting over the ice. From these data, as shown in Table 2, the "bears seen per flying hour" and the "square miles viewed per bear seen" were computed.

TABLE 1. SUMMARY OF KNOWN POLAR BEAR KILL IN ALASKA, 1956-57 AND 1957-58.

	Bears Taken	
	1956-57	1957-58
Sex of bear:		
Male	95	67
Female	59	21
Unknown	52	40
	206	128
Age of bear:		
Adult bears	182	77
Cubs and young	24	21
Unknown	0	30
	206	128
Hunting method:		
Aircraft	121	85
Other	85	43
	206	128
Type of hunter:		
Native	78	40
White	126	88
Unknown	2	0
	206	128
Residence of hunter:[1]		
Resident	131	....
Nonresident	62	....
Unknown	13	....
	206	128
Season:		
November-February[2]	37	33
March-April	124	93
May	3	[illegible]
Unknown	42	1
	206	128

[1]Not recorded in 1957-58.
[2]Predominantly killed by natives.

The data, if interpreted literally, indicate an increase in the number of bears, for the bears seen per flying hour nearly tripled from 1956 to 1958. The increase may in part be caused by increased ability of the observers, but at any rate, there is no evidence of decrease.

In 1958, pilots were asked to plot their flight routes, the location of bears seen, and of bears killed. Such records were obtained for 64 flights during which 187.6 hours were spent looking for polar bears, 203 bears were sighted, and 47 of these were killed. The flights ranged as far as 150 miles west of Point Hope (verified by radar observations); in fact, 11 of the 21 bears reported by hunters based at Kotzebue were taken west of the International Date Line—that is, they were literally "killed tomorrow and brought back today."

Tovey and Scott (1957) speculated on the order of magnitude of

TABLE 2. SUMMARY OF BEARS SEEN PER FLYING HOUR AND PER SQUARE MILE VIEWED, 1956, 1957, AND 1958, AS AN APPROXIMATE INDICATION OF RELATIVE DENSITY.

Area Hunted	Year	Flying Hours[1]	No. of Bears Sighted	Bears Sighted/ Flying Hour	Square Miles Viewed[2]	Square Miles/ Bear
Kotzebue	1956	84	33	0.4	1,888	57
	1957	222	175	0.8	4,971	28
	1958	106	111	1.0	2,387	22
	Total	412	319	0.8	9,246	29
Barrow	1956	....	....	....	....	....
	1957	161	47	0.3	3,379	72
	1958	78.5	90	1.2	1,764	20
	Total	239.5	137	0.6	5,143	38
Barter	1956	....	....	....	....	....
	1957	....	....	....	....	....
	1958	2.5	2	0.8	56	28
	Total	2.5	2	0.8	56	28
Combined	1956	84	33	0.4	1,888	57
	1957	383	222	0.6	8,350	37
	1958	187	203	1.1	4,207	21
	Total	654	458	0.7	14,445	32

[1]Includes only time actually hunting.
[2]Based on pilot's estimate of ¼ mile strip effectively covered while hunting (usually tracking or searching for tracks).

the polar bear population of Alaska and of the entire Arctic. They state: "A 75-mile wide strip along the Alaska coastal areas where bears occur would contain about 80,000 square miles. If bears were as abundant as one per 37 square miles, as indicated by the bears sighted data for 1957, this area might contain as many as 2,000 or more animals. If similar calculations were extrapolated to cover the periphery of the entire polar basin, with a conservative estimate of 600,000 square miles within a 75-mile wide strip, the possible bear population would total 17,000 animals. The 37 square miles per bear figure undoubtedly overestimates average bear abundance, but the other calculations do not include a large portion of the polar basin area, so it is difficult to evaluate the above estimates." If the combined figure of 32 square miles per bear is used, the estimate becomes approximately 2,500 bears in Alaskan waters and 19,000 in the World. It is probably safe to say, however, that bear numbers off the Alaska coast must amount to several hundreds, and that they must number in the thousands throughout their circumpolar range.

The life equation and breeding biology of the Alaska brown bear is apparently quite similar to that of the polar bear, and it is interesting to compare what is known of their relative productivity. Kodiak Island contains about 4,000 square miles of bear range, and an estimated brown bear population of about 1,600 animals. The annual kill on this area has averaged about 200 bears for each of the last five years, and it is considered stabilized at this level. The polar bear kill in Alaska has probably not exceeded 200 annually over a considerable period, and it is not difficult to assume that this kill has been drawn from an area containing as many as 1,600 polar bears, especially when the probability of annual recruitment from elsewhere in the Arctic is considered.

World Harvest

The total harvest of polar bear is unknown, but with the help of information provided by the Canadian Wildlife Service *(in litt.)* for Canada, Odd Berg *(in litt.)* for Norway, Ph. Rosendahl *(in litt.)* for Greenland, and Aleksandr Ishkov *(viva voce)* for the U.S.S.R., an estimate is possible. The data presented in Table 3 for Alaska, Canada, and Greenland are detailed and presumably quite accurate; the other data are generalizations.

TABLE 3. WORLD HARVEST OF POLAR BEARS.

Year[1]	Alaska	Canada	Greenland	Norway		U.S.S.R.
				Commercial	*Sport*	
1949-50	69	277	205			
1950-51	60	357	186			
1951-52	39	406	105	150		
1952-53	50	435	95	to	8	
1953-54	100	437	131	300	34	120
1954-55	128	507	158	a year	30	a year
1955-56	135	420	....		31	
1956-57	206				31	
1957-58	127	....	....			

[1]Figures for Greenland and Norway are for the calendar year; that is, 1949-50 is 1950, etc.

From the table it appears that the current annual harvest is on the order of 100 to 200 in Alaska, 400 to 500 in Canada, 150 to 200 in Greenland, 150 to 300 by Norwegians, and perhaps 100 to 150 by the Soviets. Thus, the total annual harvest probably ranges on the order of 900 to 1,350. Aside from Alaska, where about two-thirds of the bears are taken by trophy hunters, the only kill by trophy hunters is approximately 30 bears a year from Mr. Odd Berg's Norwegian vessel.

The rather marked declines in polar bear numbers reported from Greenland by Spark (1956) and from the U.S.S.R. by Sdobnikov (1956), are probably attributable to shifts in bear populations rather than to a decline in the World population.

International Protection

Some protection is afforded the polar bear in all waters on the periphery of the Arctic Basin. In Greenland, the taking of cubs, or females with cubs, is prohibited; Norwegian nationals are permitted to capture cubs only upon issuance of a permit conditioned upon prior arrangements with a bona fide zoological park; in Canada, only natives are permitted to kill polar bears; and in the U.S.S.R., the killing of these bears is to be prohibited. In Alaska, the killing of females with cubs is prohibited.

The greatest need for further protection at present would seem to be legislation permitting control of United States nationals on the high seas; at present, control is effective only within territorial waters.

THE PACIFIC WALRUS

The status of the Pacific walrus is somewhat more alarming than that of the polar bear. Dr. Francis H. Fay, in his report to the North American Wildlife Conference in 1957, documented a decline from an estimated 200,000 in the mid-19th century to an estimated 45,000 today. This marked decline, and the pattern of use by Alaskan Eskimos, led to renewed interest in this mammal. Largely through the efforts of Clarence J. Rhode, Regional Director of the Bureau of Sport Fisheries and Wildlife for Alaska, cooperative studies were initiated in the spring of 1958. These studies, and pertinent material from the literature, were summarized by Buckley (1958).

The Pacific walrus population inhabits the Bering and Chukchi Seas, moving northward in the spring and early summer and southward during the fall and winter. In the course of their movements, they are in the territorial waters of both the United States and the U.S.S.R., as well as on the high seas. The animals follow the southern edge of the ice pack and thus always have an area to haul out on immediately above a rich source of food. Certain groups, usually of males, haul out on shore, as in the Walrus Islands in Bristol Bay on the American side and at two or three hauling grounds on the Chukotsk Peninsula on the Siberian side. Occasionally, especially in the course of southward migration in the fall, walruses of both sexes and all ages haul out on land. The Diomede Islands in the Bering Strait are among the places frequented at this time of year.

The points of special significance for application to management are:

Mortality in the walrus population is essentially all from human exploitation. Food supplies are believed to be adequate to support much higher populations than now exist.

The estimated annual kill in Alaskan waters is 2,200; only about 1,100 are actually recovered, and the other 1,100 are lost by sinking before they can be harpooned. In addition to the waste of half of the walruses killed through nonrecovery, there is additional waste of approximately half of those walruses recovered. In Siberian waters the kill is estimated at 8,300. Thus, the total kill is estimated at 10,500, or 23 percent of the estimated total population.

The annual recruitment is on the order of 11 percent. Thus, mortality is estimated at more than twice the recruitment, and the population is continuing to decline. Other evidence confirms this decline.

Walruses are harvested for human food, dogfood, hides for boat coverings, and for ivory. Females and young are preferred for food. Hunting for ivory alone is practiced at many locations. The most practicable way to discourage this hunting is to remove the incentive, which could be done by prohibiting the sale of raw ivory.

Hides of mature male walruses are worth approximately $150, f.o.b. Seattle. Very few hides have reached the market since export became legal in 1956. Encouraging sale of suitable hides would result in greater value being received from the animals killed.

Trophy hunting by whites results in a greater value of the individual walrus killed. It also reduces the amount of time that can be spent on other walrus hunting by the Eskimos acting as guides, and thus reduces the kill.

CONCLUSIONS

1. Although hunting polar bears in Alaska with the use of aircraft may be esthetically displeasing, there is as yet no evidence that it is biologically harmful. The predominance of males in the kill of this polygamous species lessens its effect on the population. Annual variations in the availability of bears probably are caused chiefly by regional variations in food and ice conditions rather than by the effects of hunting.

2. There is no evidence as yet that present rates of harvest are harming the World polar bear population, although decreases in the number of bears available are reported for Greenland by Spärk (1956) and for the U.S.S.R. by Sdobnikov (1956).

3. An adequate method for determining accurately the magnitude and characteristics of the annual kill in Alaska should be devised and applied. Research should be continued and intensified regarding polar bear distribution, movements, life history, and ecology.

4. The circumpolar nature of the population and the international movement of polar bears are significant features of their distribution. International cooperation should be solicited for a program of research and management of polar bears throughout their circumpolar range.

5. The Pacific walrus population occurs in international waters,

as well as in territorial waters of the U.S.S.R. and the United States. Thus, international cooperation is necessary to effectively census the population and to regulate the harvest.

6. The only hauling ground regularly used by walruses in Alaska is in the Walrus Islands in Bristol Bay. The walruses there should be given complete protection.

7. Legislation is necessary to permit control of United States nationals on the high seas.

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DISCUSSION

CHAIRMAN SCHEFFER: Grancel Fitz, from the New York Zoological Society, who if I am correct, took the number one walrus under the trophy hunting laws of Alaska. Grancel Fitz.

MR. GRANCEL FITZ [New York Zoological Society]: Thank you.

What I want to talk about for just a minute or two is not walrus, which I think has been adequately covered, but the polar bear situation.

It is interesting to me to learn that quite a few men who have never seen a live polar bear are distinctly disturbed that animals of that nature are hunted by the use of airplanes, and they regard that as the most unsportsmanlike method that could possibly be used.

I am afraid that I have got to disagree completely, and I feel that it is the only sportsmanlike method of hunting polar bear.

In contrast, the alternate method would be hunting by ship such as the Norwegians practice in the Atlantic.

In that case, I might add that many Polar Bears are taken from a ship where a plane hunter gets one, and Polar Bears in the Atlantic and those that have been taken by ship in the Pacific, which is rare, do not know what a ship is, and they do not care. The man sits on the deck, rests his rifle over the rail, and assays nature, and the beast that stands up to look at him has not got the foggiest notion what he is. Then they drift the ship over and hoist him aboard with a winch.

That to me is not a sport.

In the case of the plane, Arctic flying is definitely hazardous, which introduces an interesting element of risk.

Aside from that, it gives you the opportunity to get out on the ice, on your own two feet with the bear, which is another sporting aspect.

In 1949, I had the privilege of flying 5100 miles over the ice pack without seeing a polar bear at all, but I did stop in every Eskimo village between Nome and Point Ley, and got a great deal of information about them. I do not think that the use of airplanes constitutes the slightest threat, because the take is trifling.

However, I am definitely concerned about the use of airplanes in the spring hunting of grizzlies, because there it does constitute a serious threat.

Take the case of that guide and his hunter, where both got killed a couple of years ago as an example. In that case, the threat was to the hunters. But what happens is that a bush pilot goes out in the Spring, sees the tracks in the snow where the grizzly has gone out, and goes back to the post, and get a friend, and hightails it up there, and they walk up and pry the grizzly out of his den. That is dangerous to the welfare of the species.

DR. BUCKLEY: Thank you, Mr. Fitz. It is unfortunate that time does not permit further discussion. May I simply point out that polar bear hunting from small aircraft may be esthetically displeasing but not necessarily biologically harmful.

FOOD HABITS OF WILD MALLARD DUCKS IN THREE LOUISIANA PARISHES

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Little recent information has been published regarding the food habits of specific kinds of wild ducks while on their wintering grounds in Louisiana. McAtee (1918) analyzed 1725 gizzards of mallards, many of them accompanied by well filled gullets. His material came from 22 states and 2 Canadian Provinces. General information on 17 species from the Gulf Coast was summarized by Martin and Uhler (1939). Their study covered 2101 stomachs that were collected from 38 locations from Florida to Texas. Singleton (1953) analyzed 1017 stomachs from 20 species of ducks collected from Texas. They included 293 ducks from the upper coast, 502 from the central coast, 120 from the lower coast, and 102 from inland lakes. In 1957, I reported upon the food of 188 ducks of 5 species from the same Louisiana Parishes as covered in the present study. This paper concerns only the mallard *(Anas platyrhynchos)*.

It is based on personal observations and on the analysis of the contents of 106 gullets and 125 gizzards taken from mallards collected in Cameron, Acadia and Vermilion Parishes, Louisiana. Collections were made each winter from November 1954 through January 1958.

In this study gullet material proved superior to gizzard material since gullet material reflects immediate usage by the birds. Gizzards may contain hard seeds that have accumulated over a week or more.

DESCRIPTION OF THE AREA

The collections were made in two land resource areas, the Gulf Coast Marsh and the Coast Prairie Land Resource Areas.

1. The Gulf Coast Marsh Land Resource Area consists of extensive areas of both fresh and salt marshes. The collections were made in the fresh marsh area close to the Coast Prairie. Vegetative conditions have undoubtedly changed from the original conditions as a result of water control. Structures, such as control gates, levees and pumps, have been installed to assure having water on the areas to attract wild ducks when the hunting season opens. The fall season is usually dry through the middle of November in this part of Louisiana.

   Emergent plants in these marshes include extensive stands of bulrushes, Jamaica sawgrass, giant cutgrass, arrowheads, cockspur and others. These communities are interspaced with open water areas which produce submerged plants such as bladderworts, stoneworts, waterlilies, floating-heart, naiad, watershield and others.

2. The Coast Prairie Land Resource Area was formerly a variety of climax grasses of value to geese, but of little value to ducks. Although some of this resource area is still in native range, most if it has been converted to rice growing. Instead of native grasses we now have domestic rice and a variety of grasses and weeds associated with rice growing.

   Williams (1956) listed plants that occur on rice or fallow rice fields. They include grasses such as redrice, junglerice, barnyardgrass, knotgrass, longtom, bermuda, fall panics and signalgrass. Legumes include bagpod, rattlebox, jointvetch and sennabean. Forbs include birdeye, asters, snow-on-the-prairie, sumpweed, piefruit, teaweed, smartweed and water primrose. Sedges include horned beakrush, several spikesedges and other sedges.

RESULTS

During the hunting season most of the mallards in this section of Louisiana do their daytime loafing on open water in the marshes. At night they fly many miles to feed in the rice-growing area and remain there until human disturbance causes them to return to the marshes.

This flight pattern is substantiated by the fact that the gullets from the ducks, a large percent of which were shot in the marshes several miles from the rice fields, were filled with rice and seeds of other plants associated with rice culture. These gullets contained little food that had been obtained in the marshes where the ducks were shot.

Table 1 shows that almost 90% of the food in the 106 gullets examined consisted of rice and seeds of plants associated with rice growing. None of the native marsh plants was important in gullets of the ducks studied, although most of the ducks were shot in marshes. The percent of rice found in this study was not as high as shown by Singleton (1951, 1953). However, it was considerably higher than was shown by Martin and Uhler (1939).

TABLE 1. MAJOR FOODS IN 106 MALLARD *GULLETS* COLLECTED DURING HUNTING SEASONS FROM NOVEMBER 1954 THROUGH JANUARY 1958 IN ACADIA, CAMERON AND VERMILION PARISHES, LOUISIANA

	Times Used	*Volume %*
Rice	58	24.3
Junglerice	61	20.7
Brownseed paspalum	64	19.2
Barnyardgrass	51	8.0
Red rice	41	8.0
Knotgrass	12	6.5
Signalgrass	17	2.5
Coast cockspur	12	1.9
Jamaica sawgrass	8	1.3
Snails	27	1.0
Flatsedge	3	1.0
Insects	30	.7
Fall panic	10	.6
Unidentified vegetation	1	.4
Birdeye	12	.3
Swamp smartweed	17	.2
Squarestem spikesedge	4	.2
Smartweed	13	T
Schreber watershield	2	T

The rice acreage control program has reduced the acreage of rice planted since 1954. This has resulted in more idle or grazed land. Most of the rice irrigation levees are left in place on the old rice fields. These trap water and thus encourage water-tolerant plants such as the barnyardgrass group, knotgrass, longtom and sedges. Grazing livestock on these abandoned rice fields encourages such plants as brownseed paspalum, legumes and forbs which are unpalatable to cattle. Brownseed paspalum is an increaser on rangeland. Rains or water management in the fall and winter make seeds of these plants available to ducks. Mallards feed over the whole rice-growing area in years of favorable moisture. Dry years or a dry season will concentrate birds on irrigation reservoirs, flooded fields, marshes, or other water areas.

The relatively large "unidentified" category of plant material in Table 2 consisted of seeds or vegetation that were ground too small to readily identify. Some of this material could have been soft plants

TABLE 2. MAJOR PLANT FOODS FOUND IN 125 MALLARD *GIZZARDS* COLLECTED DURING HUNTING SEASONS FROM NOVEMBER 1954 THROUGH JANUARY 1958 IN ACADIA, CAMERON AND VERMILION PARISHES, LOUISIANA.

	Times Used	*Volume %*
Rice	42	20.4
Unidentified vegetation	41	18.0
Jamaica sawgrass	69	13.6
Junglerice	26	11.0
Squarestem spikesedge	59	8.5
Brownseed paspalum	38	8.1
Barnyardgrass	29	3.3
Schreber watershield	39	3.2
Stonewort	3	2.4
Coast cockspur	7	1.8
Knotgrass	8	1.7
Red rice	14	1.6
Flatsedge	2	1.4
Smartweed	6	.7
Insects	3	.5
Signalgrass	8	.3
Birdeye	2	T
California bulrush	5	T

like widgeongrass, waterhyssop, duckweed or other water plants.

Although the gizzards showed significant amounts of the six easily digested seeds found in the gullets, you will note that gizzard analyses tend to give a low rating to the easily digested rice field seeds in favor of hard marsh seeds that persist in the gizzard.

TABLE 3. FOR CONVENIENCE IN COMPARING GULLET AND GIZZARD CONTENTS, TABLES I AND II ARE COMBINED IN TABLE III.

	Gullets		*Gizzards*	
	Times Used	*Volume %*	*Times Used*	*Volume %*
Rice	58	24.3	42	20.4
Junglerice	61	20.7	26	11.0
Brownseed paspalum	64	19.2	38	8.1
Barnyardgrass	51	8.0	29	3.3
Red Rice	41	7.6	14	1.6
Knotgrass	12	6.3	8	1.7
Signalgrass	17	2.5	8	.3
Jamaica sawgrass	8	1.2	69	13.6
Snails	27	1.0	....	....
Flatsedge	3	1.0	2	1.3
Insects	30	.7	3	.5
Unidentified vegetation	1	.4	41	18.0
Birdeye	12	.3	2	.1
Swamp smartweed	17	.2	6	T
Squarestem spikesedge	4	.2	59	8.4
Smartweed	13	.04	6	.7
Schreber watershield	2	.02	39	3.2
Stonewort	....	....	3	2.4

Table 3 shows that the occurrence and volume percent of some of the easier digested seeds are distorted by hard seeds which persist in the gizzard. Gizzard analyses may be expected to exaggerate daily consumption of some hard seeded plants from 2 to 10 times (or even more) since hard seeds may remain in the gizzard for a week or more. Also, ducks may pick up small amounts of these hard seeds while dabbling on the loafing grounds since Jamaica sawgrass, squarestem spikesedge, Schreber watershield and stonewort are common plants there.

MANAGEMENT SIGNIFICANCE

There are close to five million acres of gulf coast marshes in Louisiana. Some mallards spend the winter season in the depth of these marshes, but waterfowl census records show that a large percentage of them stay in or near the rice-growing areas. Losses of natural marshes to oil activity, boat channels, industrialization, drainage, and others have taken place in the past. Some additional losses can be expected from the same activities. However, rice farming and growing duck foods on agricultural lands can more than compensate for this loss for many years to come.

In addition to the apparent preference of mallards for foods found in rice fields, the low and erratic production of natural marsh foods limit the duck carrying capacity of marshes. For example, coast cockspur yields measured in Vermilion Parish varied from 51 pounds to 686 pounds per acre, but averaged only 244 pounds per acre. This plant is important when there is a good stand over several hundred thousand acres of the gulf coast marshes as there was last year. However, it is not dependable, and most years the crop is very light.

Singleton (1951) reported on yields of what he considered to be 10 of the better seed-producing plants for waterfowl in the marshes. Maximum production was 910 pounds per acre; however, the average of the 10 plants was 369 pounds per acre. Rice farmers lose up to this much rice during normal harvest operations. Three fields checked in Cameron Parish showed 160 pounds, 320 pounds and 347 pounds of rice on the ground following harvest operations. These poundages are of domestic rice only; they do not include the grass and weed seeds associated with rice growing.

Perhaps, more important than quantity is quality. Kimble (1958) while working on his graduate thesis had rice, barnyardgrass and Jamaica sawgrass analyzed. The results are shown in Table 4.

It appears from this analysis that a pound of easily digested rice field seeds contribute more to duck welfare than a pound of hard seeds from the marsh.

In addition to the large quantity of high quality duck foods produced incidental to rice growing, some landowners and operators are planting duck foods such as browntop millet for duck food in fallow rice fields. Millet planted in July and August matures seed in Sep-

TABLE 4. ANALYSIS OF THREE COMMON PLANTS USED BY DUCKS

	Moisture	Crude Protein	Fats	Ash	Crude Fiber	Nitrogen Free Extract
Rice	12.4	7.4	0.4	0.4	0.2	79.2
Barnyardgrass	12.0	11.1	3.7	2.6	7.7	62.9
Jamaica sawgrass	5.6	6.3	2.2	8.6	32.1	45.2

tember to October (55-60 days). Progressive flooding of the field puts new food in the water every two or three weeks. The rice field irrigation and drainage system lends itself to this type of water management. Progressive flooding prevents large numbers of birds from cleaning up the food in the field in a few days. Also, this type of flooding prevents all the food from deteriorating before the birds go north in the spring. Rice farmers prefer browntop millet over plants that compete with rice, such as barnyardgrass and junglerice. Browntop millet is grown under a dry land culture and flooded only after the seeds are mature. The plant will not grow in water as rice field weeds do.

Some landowners and operators are using areas that are not farmed to rice to produce Japanese millet, barnyardgrass, smartweeds, etc., for duck foods. Volunteer stands of smartweeds were checked for seed yields in Vermilion Parish in 1955 and 1956. These unmanaged fields produced from 600 pounds per acre to 2,072 pounds per acre of smartweed seeds, with an average of 1,175 pounds per acre. Methods to assure dependable production of such foods have not been developed as yet in Louisiana. To receive farmer acceptance, duck food plants must be dependable, produce high yields, and not be a pest in rice fields.

An exotic, signalgrass, grows over most of the rice area of Louisiana. It has similar qualities to browntop millet, but will grow under slightly wetter conditions. It is a high seed producer, but is not considered a serious pest in rice fields because it does grow well in water. Methods for the production of this grass are being developed.

TABLE 5.

a. *Choice:*	Barnyardgrass; junglerice; paspalum (brownseed, knotgrass); rice.
b. *Inferior:*	Birdeye; cockspur (coast); flatsedge (fragrant); panicum (fall); paspalum (hairyseed, longtom, water); saltgrass (seashore); sawgrass (Jamaica); signalgrass; smartweed (swamp, Puerto Rico); spikesedge (common, jointed, squareestem); stonewort; sumpweed; water-lily (small, American); watershield.
c. *Unimportant:*	Amaranth (redroot); bulrush (softstem, California); buttonbush; croton (woolly); dodder; fimbry; fescue (meadow); melochia (cluster); mermaid-weed; morningglory; rush; ryegrass.

Below I have listed mallard foods based on this study as "choice," "inferior," and "unimportant." They are rated on the basis of volume and occurrence. To be rated as "choice," they must be available, abundant, nutritious, and readily acceptable.

CONCLUSIONS

1. Hard seeds occurring in mallard gizzards are misleading as to importance as food. Jamaica sawgrass, squarestem spikesedge, Schreber watershield, stonewort, waterlilies and dodder are apparently hard enough to serve as grit and to remain in the gizzard for a period of several days or even weeks before being worn away.
2. When the *gullet* is *empty* and only *hard seeds* are found in the *gizzard,* it is safe to conclude that the bird has completely digested food from the previous feeding.
3. Mallards in the area under discussion depend heavily upon foods produced on agricultural lands. Management of rice stubble fields for mallards is extensive throughout the rice-growing area of Louisiana. Acre for acre, crop residues and weed seeds associated with rice culture produce quality foods in amounts far in excess of that produced by natural marsh land. Management techniques are being developed for the production of high quality duck foods, such as browntop millet and signalgrass, on rice lands in the years that the land is fallowed.
4. A high percentage of Louisiana mallards winter on or near agricultural land.
5. Fields, where water is held on the land until the birds return to the north in the spring, are important courting grounds as well as feeding areas. When the hunting season is over the birds use agricultural lands for feeding, loafing and courting. Within a short time after the hunting season closes, the large daily flights from the fields to the marshes cease.

   This observation leaves little doubt that mallards in the section of Louisiana studied prefer rice fields to marshes for feeding and loafing. They go to the marshes in large numbers primarily because of human disturbance at the rice fields—not because the marshes are preferred habitat.
6. This study does not depreciate the value of Louisiana marshes for mallards. It does, however, demonstrate the high value of rice field crops for mallard food and points out the need for management of rice field areas, as well as for the management and preservation of marshes.

   It is my opinion that the rice-growing area of Louisiana, in combination with its vast marshes, is now capable of wintering a

LIST OF PLANTS IN DUCK FOOD STUDY

Common Name	Latin Name
Amaranth, redroot	*Amaranthus retroflexus*
Arrowhead	*Sagittaria* spp.
Aster	*Aster* spp.
Bagpod	*Glottidium vesicarium*
Barnyardgrass	*Echinochloa crusgalli*
Beakrush, horned	*Rhynchospora corniculata*
Bermudagrass	*Cynodon dactylon*
Birdeye	*Caperonia castaneaefolia*
Bladderwort	*Urtricularia* spp.
Browntop millet	*Panicum ramosum*
Bulrush, California	*Scirpus californicus*
Bulrush, softstem	*Scirpus validus*
Buttonbush	*Cephalanthus occidentalis*
Cockspur, coast	*Echinochloa walteri*
Croton, woolly	*Croton capitatus*
Dodder	*Cuscuta* sp.
Duckweed	*Lemna* spp.
Fescue, meadow	*Festuca elatior*
Fimbry	*Fimbristylis* s.p
Flatsedge, fragrant	*Cyperus odoratus*
Floatingheart	*Nymphoides aquatium*
Giant cutgrass	*Zizaniopsis miliacea*
Jointvetch	*Aeschynomene* spp.
Junglerice	*Echinochloa colonum*
Knotgrass	*Paspalum distichum*
Longtom	*Paspalum lividum*
Melochia, cluster	*Melochia corchorifolia*
Mermaid-weed	*Proserpinaca* sp.
Morningglory	*Ipomoea* sp.
Naiad	*Naias* spp.
Panicum, fall	*Panicum dichotomiflorum*
Piefruit	*Sphenoclea zeylanica*
Paspalum, brownseed	*Paspalum plicatulum*
Paspalum, water	*Paspalum hydrophilum*
Rattlebox	*Daubentonia drummondi*
Rice, common, domestic	*Oryza sativa*
Rice, red	*Oryza sativa* var.
Rush	*Juncus* sp.
Ryegrass	*Lolium* sp.
Saltgrass, seashore	*Distichlis spicata*
Sawgrass, Jamaica	*Cladium jamaicense*
Sedges	*Carex* spp.
Senna	*Cassia* spp.
Signalgrass	*Brachiaria platyphylla*
Smartweed	*Polygonum* spp.
Smartweed, Puerto Rico	*Polygonum portoricense*
Smartweed, swamp	*Polygonum hydropiperoides*
Snow-on-the-prairie	*Euphorbia bicolor*
Spikesedge, common	*Eleocharis palustris*
Spikesedge, jointed	*E. equisetoides*
Spikesedge, squarestem	*E. quadrangulata*
Stonewort	*Chara* sp.
Sumpweed	*Iva* sp.
Waterhyssop	*Bacopa* spp.
Waterlily, American	*Nymphaea odorata*
Waterlily, small	*Nymphaea odorota minor*
Waterprimrose	*Jussiaea* spp.
Watershield, Schreber	*Brasenia scherberi*
Widgeongrass	*Ruppia maritima*

larger population of mallards than that section of Louisiana was able to support in its original condition. I don't think we should be satisfied with the present or past mallard populations. With skilled attention to the management of the rice-growing area and the preservation and management of the better fresh-water marshes, we can winter and send back to the nesting grounds more mallards in better breeding condition than was possible before the advent of rice growing.

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LATE NESTING OF WATER BIRDS IN SOUTH TEXAS[1]

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Relatively little information is available on waterbird production in South Texas and still less on the degree of late nesting. The commonly held opinion is that marsh or waterbird nesting, and especially late nesting, is so uncommon here that it is quite unimportant either actually or potentially. The facts show rather conclusively that when environmental conditions are favorable there is substantial nesting in this section of the state, and much of it occurs surprisingly late in the season. Our studies have been restricted to the rather late summers of 1957 and 1958 at a series of five

[1]Contribution # 33, Welder Wildlife Foundation.

shallow natural lakes aggregating about 242 acres of marsh and water on the 7,800 acre Welder Wildlife Foundation Refuge located some thirty miles north of Corpus Christi and ten miles northeast of Sinton, Texas.

Because of our building program and other essential field work, only cursory surveys have as yet been made of these areas in the spring and early summer, and much more intensive work is needed even for the late summer. In 1957, field study was not commenced until the last day of July, while in 1958 some study started on June 9, but more intensive work did not begin until the middle of July. By the first of August in 1957 and July 1, 1958, only the two largest lakes contained enough water to make them attractive for nesting. The shallow lakes with the most vegetation attracted most of the nesting birds early in the season.

From July 31 to September 5, 1957, when nesting ceased, we located and studied the histories of 170 nests of six species of waterbirds. In addition, two broods of bluewinged teal were observed that hatched on the refuge about August 1. In 1958, from June 9 to the end of August, 340 nests of eight species were located and studied, and one brood of eleven black-bellied tree ducks, hatched after September 15, was observed.

It should be pointed out that all of the ducks, coots, and gallinules are considered game species. In addition to the above, black-necked stilts, killdeer, green herons, mesquite grackles, and red-winged blackbirds were nesting on or adjacent to the lakes but were not included in these studies.

The facts obtained reveal several surprises. The nesting of blue-winged teal this far south, and particularly this late in the season, was entirely unexpected as was the late nesting of the black-bellied tree ducks and the surprising numbers of the dimunitive Mexican or least grebes so far north. It was expected that all of the other species would be rather uncommon summer visitors to this section of the State. The principal conclusion to be drawn is that ornithology in South Texas is still imperfectly known and needs to be studied.

Table 1 gives a summary of the recorded late summer nesting at the Welder Wildlife Refuge.

HABITS AND NESTING SUCCESS OF SUMMER NESTERS

Tree Ducks: Some 6 to 20 individuals of the attractive black-bellied tree duck *(Dendrocygna autumnalis autumnalis)* were with us from mid-July until the end of September, and a few, particularly

TABLE 1. NESTS AND BROODS STUDIED

Species	Pollito 60 Acres 1957-1958		Big Lake 125 Acres 1957-1958		Tule 50 Acres 1957-1958		Millet Pond 4 Acres 1957-1958		Aster Slough 3 Acres 1957-1958		242 Acres Species Totals 1957-1958	
Blue-winged Teal[1]			2								2[2] 0[3]	2[4]
Black-bellied Tree Duck[1]				1							0 1	1
Fulvous Tree Duck		5	2	1	7		2				11 6	17
Coot	36	24	22	32	6						64 56	120
Florida Gallinule	19	72	22	61	1	10		1		11	42 155	197
Purple Gallinule	9	40	2	7	11	38		1		1	22 87	109
Pied-billed Grebe	9	8	14	3		1					23 12	35
Mexican or Least Grebe	8	8									8 8	16
Least Bittern						1		3		5	0 9	9
Little Green Heron		7									0 7	7
Totals	81	164	64	105	25	50	2	5		17		
Grand Total	245		169		75		7		17		513	

[1]Broods only. [2] = 1957; [3] = 1958; [4] = totals.

the young, until late in October. About the same size as the fulvous *(D. bicolor helva)*, the black-bellied seems to be dominant even though the fulvous is much the more common and both species frequently associate together. Unlike most ducks, both parents stay together and care for their brood. One brood of 11 was seen on September 30 and was, perhaps, ten days old. They were with the female, following her close to the shoreline. When the observer appeared, the male, which was feeding about 1/4 of a mile away, left his small flock, circled the brood and landed at their rear. The female then led them to the center of the lake in single file with the male following. This procession in single file, with the female in front and the male at the rear, suggests an affinity with the geese and particularly with Canadas.

These long-necked, long-legged diving ducks are known to have a long nesting season, extending from May to October. The majority in South Texas (mainly in the lower Rio Grande Valley) nest rather late in the summer. They normally nest in holes in trees in which there is some semblance of a peep-hole. Nest trees are usually in close proximity to open water.

The term "tree duck" as applied to the fulvous is largely a misnomer as they are seldom seen near trees. Others (Bent, 1925), however, give evidence that occasionally this shy, nervous nester, more commonly and appropriately known as Mexican squealer, builds its nest in hollow trees as does the black-bellied. From 100 to 250 of these birds spent the latter half of the summer with us from mid-July to mid-November. A small vanguard appeared a month or so earlier. The numbers thinned out by the last of October and by the last of November only a dozen remained. Six birds, believed to be a family group, have continued with us throughout the winter. A year ago the last fulvous was seen on the Welder area on January 17.

This retiring, long-necked, goose-like duck, which is a little above medium size, usually nests in very dense vegetation and in our area almost invariably over water. The flight pattern of both "tree ducks" is quite irregular, and they move about in flocks without organization or form and quite unlike the V-shaped trains or phalanxes so characteristic of some waterfowl. The flock seems to be held together by their inherent gregariousness. In migration, both species seem to travel mainly at night. At the Welder Refuge, the birds seem to favor specific loafing, preening and resting grounds. They usually fly, swim, feed and loaf together in relatively small flocks or groups of 5 to 50 birds.

In 1957, our population of fulvous tree-ducks was less than 50% of the 1958 population; yet nesting conditions seemed to be much more favorable in 1957 as 11 nests were found in this year which were 72.7% successful, while only six nests were found in 1958 and these were only 16.7% successful. A successful nest is one in which some part of the clutch hatches. The 11 nests of 1957 were well hidden in dense vegetation and therefore were hard to find. Nesting sites were in dense stands of *Paspalum, Leersia, Astor spinosus, Typha,* or *Echinodorus*, or a mixture of these and other water-loving plants. This year these favored areas were too dry so the birds nested on young or matted stands of *Paspalum* and the nests were exposed in all but one instance.

Normally, the completed nest is beautifully and compactly made and lined with fine vegetation and occasionally with a few feathers. The nest seems to be built largely during the period of egg laying. Frequently, some of the first eggs of the clutch fall through the early flimsy nest structure and into the water. Consequently, the clutch size varies considerably—in this study from 6 to 16 eggs. Of the eleven 1957 nests, 122 eggs were deposited and 85 or 69.7% hatched. The six 1958 nests produced a total of 42 eggs and 9 or 21.4% hatched. Considering only the nine successful nests of both years, 113 eggs were incubated and 94 or 83.2% hatched and 19 or 16.8% were unsuccessful. Incubation does not seem to start until all eggs are deposited and all young normally hatch during a 24-hour period. Other workers (Bent, 1925; Dawson, 1932; and Kortright, 1942) report communal, composite, or "dump" nests aggregating 50 to 100 eggs. This promiscuity in egg deposition apparently is more common early in the season and did not occur at the Welder Refuge. It appears that second attempts at nesting produce smaller than the average clutch size.

The eggs seem to average slightly smaller than those of most waterfowl of comparable size. They tend to be short ovate although some are bluntly ovate or nearly oval. When fresh, the eggs are beautifully ashy white and smooth, but as incubation advances the white luster is replaced by a light buffy gloss that shows minute pitting. Bent (1925) found that 212 eggs in various collections averaged 53.4 by 40.7 millimeters in size.

The eggs in our area were never covered with down or vegetation when the female was off the nest, and we had a feeling that the parent birds spent relatively little time on the nest during the warm day-light hours until the eggs were about ready to hatch. Apparently, this was sufficient for successful incubation.

Fulvous tree ducks are "nervous nesters" and, if conspicuously or repeatedly disturbed during the early stages of nesting, are likely to desert the nest and probably be driven out of a localized area. Our systematic search for nests and the inadvertent placing of a 20-inch cardboard box on a favored but small loafing island near a good nesting area seemed to cause most of our birds to desert the Refuge in 1957 for a week to ten-day period and during this time two and possibly three nests were deserted. During the past summer one nest with one egg and one with five eggs were deserted. Two were destroyed by a raccoon or coyote and one was damaged by a wading steer. It appears that the mother bird usually remains at the nest during the full period of hatching. Sometimes, before the last few eggs hatch, the mother leads her brood of precocious young away from the nest site.

The downy young form an attractive study of brownish-black and white. The young are as different from other species of ducklings as the distinctive parent birds differ from the appearance of other waterfowl. The young possess an inherent alertness and if pursued, dive with the skill and dexterity of a grebe. Their protective coloration and ability to hide gives them high survival value. The parents likewise are expert divers and commonly feed by diving. They also forage, as do surface feeders, by "tipping" or gleaning from the surface or edge of the pond.

The fulvous tree ducks of several closely related races represent a discontinuous distribution occurring in southwestern United States, Mexico, widely separated parts of South America, India and east and southern Africa. Our birds nest from southern Louisiana, East and South Texas westward sparingly to southern California and southward over much of Mexico. Most of our birds move south throughout Mexico for the winter.

Coots and Gallinules: These can be considered together in this report because of their many affinities and close relationship as members of the family Rallidae and especially because of their somewhat similar nesting habits. The parent bird usually leaves the nest site with her precocious young when a third to a half of the eggs are hatched. The young that hatch after the parent bird has left the nest must forage for themselves as best they can. Because the young are highly precocious and receive little food from their parents, probably some of the deserted ones survive and attach themselves to other broods, but mortality obviously is high.

Incubation seems to start considerably before the full clutch is deposited, so the young may hatch out over a period of from 2 or 3 days to well over a week. There also seems to be some inter- and intraspecific nesting parasitism, particularly with coots *(Fulica americana americana)* and Florida or common gallinule *(Gallinula chloropus cachinnans)*. There is also some competition between coots and Florida gallinules.

One nest had been built and 2 eggs laid in it by a Florida gallinule. A coot then apparently dispossessed the gallinule and further built up the nest and covered the 2 eggs with some three inches of coarse nesting material. Over a period of perhaps ten days, 10 coot eggs and 1 Florida gallinule egg were subsequently deposited in the new second story nest and by August 6, one egg was pipped. Six days later, on August 12, three young coots had hatched and 7 eggs remained. Apparently the one gallinule egg in the coot nest also had hatched. On August 19, the nest was empty, but 4 downy coots were searching for food around the nest and to our surprise one of the entombed gallinule eggs deep in the nest structure had hatched a downy chick that was chirping loudly and struggling to get out. The nest was torn apart to free him. The little fellow was painfully thirsty and drank avidly. As soon as he satisfied his thirst he paddled off, pecking at every small floating object to get something to eat. Certainly, the egg which produced this chick had never been incubated nor turned! The temperature and humidity, however, were high. The period of incubation of this egg is not known but certainly it far exceeded the normal.

As evidence of some parasitism and promiscuity within the species, on July 24 one nest had two newly emerged young and four eggs, 2 of which were pipped. Eleven days later this nest contained six eggs and nine days still later this second clutch was hatching! From our nest history studies it appears that young begin to emerge from 17 to 22 days following completion of the clutch. Probably, this variation can be explained on the basis that some hens begin incubation before the complete clutch is laid. Parasitism by one hen laying in the nest of another could extend the period of incubation and certainly the period of hatching.

The coots and Florida gallinule usually build substantial floating nests that are firmly attached to emergent vegetation. Sometimes the nest is built in the crotch of an emergent shrub (*e.g.* huisache) or on a mat of rigid emergent vegetation such as spiny aster (*Aster spinosus*) or smartweed (*Polygonum* sp.) The eggs are always exposed when not being incubated and usually all are placed some 2 to 12 inches above the water. The water is generally from 6 to 30 inches deep at the nest site.

The purple gallinule (*Porphyrula martinica*) nest is commonly in denser vegetation and generally much higher above the water, usually from 12 to 36 inches. The nest is more secluded and, while the eggs are not covered when the female is away from the nest, the entire nest often is invisible in its dense clump of vegetation with its screen of tall branches of emergent vegetation skillfully woven around the outside of the nest. When away from the nest the two species of gallinules are rather solitary and usually remain in and about heavy emergent vegetation. The coot is more sociable and gregarious, although quarrelsome and is more inclined to feed and loaf in the open water or along the shoreline.

Clutch size varies considerably among the different species and individuals. Many of the nests of all three species in this study probably represented second attempts; consequently, clutch size is probably smaller than a comparable number of nests found earlier in the nesting season. Considering only those nests that seemed to be complete, the coot clutches varied from 4 to 13 eggs and on the basis of 82 nests studied, they averaged 7.9 eggs per completed clutch. Of the 64 coot nests observed in 1957, 48 or 75% were partially successful; 12 or 18.8% were complete failures; and 4 or 6.2% could not be accurately appraised as to whether they had been successful. In 1958, 56 nests were located. Of these 31 or 55.4% were rated as at least partially successful; 13 or 23.2% were failures; and 12 or 21.4% were not visited frequently enough for their final outcome to be determined. An avian predator, probably a marsh hawk or a great horned owl, killed one nesting coot.

Based on 142 completed nests, the secretive Florida gallinule clutch size varied from 4 to 17 eggs and averaged 9.1 eggs per set. Of 42 nests studied during the 1957 season, 30 or 71.5% were partially successful; 8 or 19% were failures; and 4 or 9.5% could not be accurately appraised. Several eggs in a number of sets were found with a double shell which probably prevented hatching. During the past season, 155 nests were found. Of these, 74 or 47.8% were successful, 49 or 31.6% were failures and 32 or 20.6% were undetermined because of too infrequent visits by the observers to the nests. The causes of nest failure could not always be determined. Raccoons or coyotes were believed to be responsible in 11 nest failures; snakes (probably moccasins) in 7; trampling by steers along the shallow margin of the ponds in 6 instances; and mesquite grackles in 4 other cases. Three nests sank, possibly because of poor construction, and one nest was believed deserted.

A number of the large clutches appeared to represent contributions of two different hens. One nest of 9 eggs that was about a week advanced in incubation had an increase of three more eggs over a two-day period. This probably was a gratuitous offering of two neighbor hens as usually but one egg is deposited per day! One nest of ten Florida gallinule eggs hatched over a period of one week, and nearly another week later a purple gallinule egg hatched which had been added to the clutch after incubation was well underway. For fully half of the incubation period, the purple gallinule egg had not been incubated or turned! A deserted nest or one left in good condition after a brood has hatched is often taken over immediately by another bird as her nesting site.

One nest of three eggs was found on June 16. On July 10, this nest contained one newly emerged downy young and nine eggs, six of which were pipped. Assuming one egg was deposited per day, the clutch of ten would have been completed on June 23. Seventeen days later the eggs were hatched. Two other nests produced young in 17 and 18 days respectively after clutches of ten eggs were laid. One nest found on July 12 had a clutch of 11 eggs. Eleven days later there were 12 eggs and three of these were hatching. We do not know whether incubation started well in advance of the completion of the clutch or whether one or more eggs of the set were added by other female gallinules after incubation was under way.

Clutch size of the smaller and still more secretive and beautiful purple gallinule showed a clutch range, based on 87 completed nests, of four to twelve eggs with an average of 6.5 eggs per nest. Twenty or 91% of the 1957 nests showed partial success and only two nests or 9% could not be appraised accurately. Nest loss was noticeably higher this past season. Of 87 nests, 39 or 44.8% were listed as successful; 16 or 18.4% were failures; and 32 or 36.8% were recorded as being undetermined. Nest failures were chargeable to grackles, rice rats, snakes, trampling by steers, and possibly desertion. The more open nests of coots and Florida gallinules were subjected to a considerably higher degree of predation than were the better protected nests of the purple gallinules.

Parasitism occurs with this species as with its relatives although probably not as commonly. All of the larger nests gave evidence of having been the product of two hens. In one nest a Florida gallinule had added an egg.

August nesting for these three species is rare in any section of the country. Bent (1926) indicates that nesting of coots is uncommon in eastern United States east of western Tennessee, eastern Arkansas and central Texas east of Decatur, Giddings, San Antonio and Brownsville. Of 147 nesting records from many sections of the country, August 2 was the very latest record and April 11 was the earliest. Dawson (1932) states that nesting in California is from April 15 to June 15 except at higher altitudes where a few nests may be found as late as July 1. Robert's (1932) monumental studies of Minnesota Birds, with one exception, lists a July record as the latest nesting coot in the state. That one exception was of a nest that hatched on the last of August. Most nesting in that state is finished by the last of June.

In Howell's (1932) studies of Florida Bird Life he concluded that the Florida gallinule nested in April and May and the elegant tropically-colored purple began nesting the last of April and continued until August, although most nesting was concluded by the first half of June.

Grebes: Pied-billed (*Podilymbus podiceps podiceps*) and least or Mexican grebes (*Podiceps dominicus brachypterus*) are related species and have unique nesting habits. The pied-billed is a widely distributed nesting species from Vancouver Island and central British Columbia, southern Mackenzie, southern Quebec and Nova Scotia southward covering much of Mexico (*A.O.U. Checklist, 1957*). The diminutive least grebe, the smallest of all American grebes, nests from southern Texas southward through most of Mexico to Panama. Bent (1919), in his Life Histories of Diving Birds, records 212 nests of the pied-billed and points out the long period of nesting which starts as early as April 4, the most incubation completed by the last of May or June. A few extended into July and at least four were not completed until August.

The Mexican grebe has an even longer period of nesting. Fifty-nine records (Bent, 1919) extend from March 3 to September 6. All but a few of these were completed before August 1. The proportion of birds nesting late is very low, indicating that perhaps this secretive little fellow may be very much more productive than has hitherto been realized in areas as far north as the Welder Refuge.

Both species invariably build floating nests that are anchored to emergent vegetation. When the adults are away from the nests it is rare that the eggs are not covered with wet decaying submerged vegetation. Both sexes participate in incubating; yet, during the warmer parts of the day, relatively little incubation by the bird was noted. This probably is unnecessary as the heat from the decaying vegetation is noticeably warmer than air temperature, so incubation proceeds even without the adult covering the eggs. On clear and relatively calm summer days between 9:00 a.m. and 5:00 p.m., the temperature of the surface of the incubating eggs under the steaming damp vegetational covering was often as high as 104 degrees or 10 to 14 degrees higher than air temperature. It seems that the grebes have learned to use the sun's energy to aid in incubation. This probably accounts for incubation starting and ending over an extended period.

The least or Mexican grebes' nests are often grouped together much closer than are the pied-bills'. Their nests were mostly located near the boundary of a relatively tall vigorous stand of smartweed or other emergents or attached to a semi-submerged small huisache. The grebe nests were located in water from 16 to 36 inches deep and all nests were anchored to emergent stems some of which did not reach the surface. Nests of the two species are very similar in appearance except that the smaller bird has a considerably smaller nest. This bird is less frequently found in open water than is its larger cousin, and it is somewhat more gregarious than the pied-billed. It seems to be most at home in close proximity to vegetation where it can quickly seek cover.

Of the 23 pied-billed nests studied in 1957, 18 or 78.3% were successful; 3 or 13% were destroyed or deserted and 2 or 8.7%

could not be accurately appraised as to whether or not they had been successful. The 12 nests of 1958 showed 91.7% success with 8.3% undetermined.

Seven of the eight 1957 Mexican grebe nests were successful and one was destroyed, presumably by a raccoon. We could not be certain whether the nest was destroyed before or after the eggs had hatched. The eight nests of 1958 showed a 100% successful hatch although two eggs of one clutch were trampled by steers.

The full clutch of the pied-billed grebe nests ranged from 3 to 8 eggs and averaged 5.4 eggs per set. The smaller grebe nests ranged from 3 to 6 eggs, averaging 4.4 eggs per clutch.

In 1957, 85.6% of the pied-billed eggs laid were hatched while 89% of the eggs of its smaller cousin were successful. In 1958, 98% and 92% respectively of the two species of grebe eggs hatched. The fact that the grebe eggs are covered when the parent bird is not incubating undoubtedly gives the eggs much better protection than is accorded nests and eggs of other water birds.

Incubation apparently starts shortly after the eggs are laid; consequently, the young hatch out over an extended period of several days to a week or more. Precocious downy young were not infrequently seen perched on a nest or paddling in near-by water when other eggs in the clutch were still being incubated or were pipped. Even at this time, the parent birds had the eggs covered and were away from the nests. Usually, the nest remained active and the remaining part of the clutch was covered even when only a single egg remained.

THE INFLUENCE OF ENVIRONMENT ON REPRODUCTION

Studies conducted here suggest that perhaps environmental conditions, especially in more southern latitudes, are a major factor inducing nest building and reproduction. Two attractive ponds on our area add confirmation to this. Tule Lake is an eastern unit with a large drainage basin. This lake had not been filled in several years until the heavy rain in the spring of 1957; yet it has had enough water each year to produce a vigorous and varied growth of submerged and emergent aquatics. By June 1957, it had a very favorable nesting environment and a large population of water birds could be found in the area.

Pollito Lake, of only slightly larger size and nearly three miles farther west, has a much smaller watershed and therefore received relatively little run-off except during heavy downpours that are of considerable duration. This lake had been dry most of the past five years until the spring of 1957. When filled, it is a foot or more deeper than Tule Lake. As would be expected, it was slower than Tule Lake in developing an optimum vegetative cover. By the time our August nest studies began in 1957, nearly all nesting was rapidly drawing to a close on Tule Lake and evidence was clear that heavy nesting had occurred there earlier. Pollito Lake probably reached its peak of nesting in June or July but still had a very attractive environment throughout August. The grebes and Rallidae are relatively sedentary on the nesting ground, and it is believed there was relatively little summer movement of these species between the different lakes of the Refuge. The facts indicate that because of environmental conditions late nesting was much heavier on Pollito than on Tule Lake. Production during August on each of our lakes can be explained on the basis of vegetative conditions.

John J. Lynch, as reported by Lowery (1955), made a special study of nesting of fulvous tree ducks in Louisiana and concluded that nest building does not commence there until the middle of July. He believed that the delay was because the young rice does not offer sufficient nesting cover before that time. Meanley (1952) found the short-billed marsh wren in rice fields of lower Arkansas postpones nesting until August and September when rice stands are suitable for nest building. Phillips (1951) points out that though sexually active in spring and early summer, the rufous-winged sparrow delays its actual nesting until the summer rains.

In tropical and semi-tropical areas that have clearly defined seasons of rainfall, nesting or resident species is usually correlated with the rainy season. The spring and summer of 1955 at the Welder Refuge was exceedingly dry with almost no green vegetation in evidence. That spring we had almost a complete failure in bobwhite quail production. Extensive soaking rains in September produced abundant growth of green vegetation. During October the first half of November a sizeable crop of quail was produced.

Studies of white-winged doves in Mexico in May of 1957 gave similar evidence that environmental conditions have a marked bearing on reproduction. Field studies and collections of birds up to May 10 showed that the birds were not quite ready to begin nesting in the dry hot belt of southern Oaxaca and Chiapas of the Isthmus of Tehuantepec. North of the east-west range of mountains that bisects this Isthmus and far northward throughout Mexico and Texas, where spring rains had occurred, this same species of bird was nesting and had produced many young. Sub-adults, more than six weeks old, were collected on the Pacific coast at San Blas. Perhaps we have partially overlooked the importance of the biological principle of environment as a major factor in reproduction, particularly in warm climates where the young could survive the winter season.

SUMMARY AND CONCLUSIONS

1. Nesting studies in late summers of 1957 and 1958 at the 7,800 acre Welder Wildlife Refuge reveal that waterbird nesting is substantial in South Texas, and that nest abundance varies with habitat conditions. Ornithology of South Texas is not well known.
2. In the late summers of 1957 and 1958, 513 nests of tree ducks, coots and Florida and purple gallinules, pied-billed and Mexican grebes, least bittern and green herons were found on the Welder refuge lakes. Other water-loving species nested near the periphery of the lakes.
3. Information on ecology and nest history is given as is also details of nesting abundance and success.
4. Parasitism was common with the observed species of Rallidae.
5. The covering of grebe eggs gave added protection and helped in incubation.
6. The importance of optimum or favorable environment as a stimulus to production probably has not been fully realized.

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DISCUSSION

MR. FRED GLOVER [Fish and Wildlife Service]: I would like to corroborate the last observation which you made on the effect of incubation temperatures, and whether the hen is present or not.

I had an opportunity to put thermocouples in a nest, and apparently the hen does know when the temperature is right, and, as Dr. Cottam says, she goes off and has herself a good time until the time is right to come back.

Incubation is continued by the sun and the decomposition of the nest.

DR. COTTAM: Because of this, the period of time in which the eggs are hatching is as variable as any that you find. For example, that is common with all the owls. It is true with the grebes. They may be a week apart. The clutch size varies in the grebes from three to eight eggs with an average of 5.4 of the pied-billed and 4.4 of the little Mexican grebe. Even when there is only one egg left, the mother will cover that egg and go off on her merry way.

It has been my observation that she returns and does take good care of her babies, much better than do any of the ducks or the gallinules.

NEW HORIZONS IN STOCKING HATCHERY TROUT

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It has been my lot recently to summarize the returns from more than 244 separate trout planting experiments with marked trout. These are reported in approximately thirty-six separate papers (see bibliography) published principally in the United States and Canada. My intent here is not to repeat to you the monotonous statistics that emerge from such a study, but rather to present some of the over-all results of various stocking practices and to offer a few alternatives for consideration. After thirty years of investigation I think it is time that fisheries workers came to a few general conclusions with regard to planting of hatchery trout. The propaganda that hatcheries are the answer still sways the thinking of the majority of anglers.

Table 1 summarizes the survival rates grouped into six different categories. Fig. 1 illustrates the same materials in graphic form. A discussion of each of these follows.

1. *Lake Plants of Fingerlings Made at All Seasons:* Creeled fish averaged 7.4 per cent of numbers planted and ranged between 36.4 and 0.06 per cent respectively. Nineteen of the 32 plants gave re-

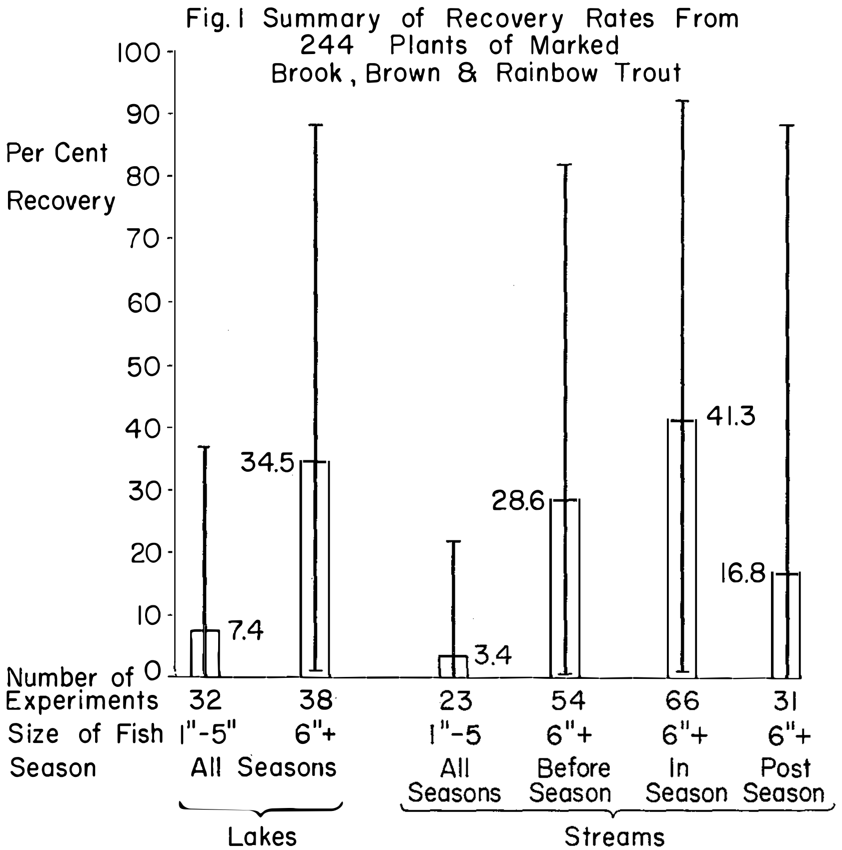
TABLE 1. SUMMARY OF RECOVERY RATES FROM 244 PLANTS OF MARKED BROOK, BROWN, AND RAINBOW TROUT AS REPORTED IN PUBLISHED PAPERS[1]

Category	Number of Separate Experiments Reported	Maximum and Minimum Percentages of Recovery	Average Recovery Rate	Remarks
Lake Plants of Fingerlings Made at All Seasons	32	36.4-0.06	7.40	Largest recoveries were obtained by Wales and German (1956) in Castle Lake, California, from 2-3 inch eastern brook planted following chemical treatment of the lake
Lake Plants of Legal-Sized or Catchables Made at All Seasons	38	88.4-1.10	34.5	Crecy Lake, New Brunswick, Canada, gave the highest returns following predator control operations (Smith, 1954)
Stream Plants of Fingerlings Made at All Seasons	21	14.0-0.00	2.5	Ten of the 21 experiments yielded less than a 1.0 percent return
Stream Plants of Legal-Sized Cathables Made in Advance of the Angling Season	54	82.0-2.60	28.6	A plant of 200 large eastern brook trout in the Deerskin River in Wisconsin gave the highest return (Willamson and Schneberger, 1943). Of the 54 experiments reported, 24 showed returns of less than 20 percent
Stream Plants of Legaly-Sized or Catchables Made During the Open Angling Season	68	92.2-1.00	41.3	Rush Creek, California, produced the highest reported returns (Vestal, 1954)
Stream Plants of Legal-Sized or Catchables Made After Close of the Angling Season	31	88.6-0.02	16.8	Highest returns in this group came from Spring Creek in Pennsylvania as reported by Trembly (1945)
Totals and Averages	244	Max. 92.20 Min. 0.00	27.2	Average is based on all sizes of fish planted regardless of species or time or place of planting

[1]Inclusion of survival data from around twenty-five days had to be omitted because of lack of pertinent information or artificial conditions of the experiments or because the subject matter did not pertain precisely to the problem at hand. Since no marked differences were observed in the survival rates reported for brook, brown or rainbow trout, the data for all three species are grouped together in this table.

coveries of less than 5.0 per cent. Highest returns were obtained by Wales and German (1956) where 2- to 3-inch eastern brook trout had been planted following chemical treatment to remove predators. Where populations of trout or other fishes are already present, survivals are usually less than five per cent.

2. *Lake Plants of Legal-Sized Trout Made at All Seasons:* Recoveries in this category averaged 34.5 per cent and ranged from 88.4 to a low of 1.1 per cent in 38 experiments. In this respect, they



were second to in-season plants of large trout in stream which gave an average return of 41.3 per cent.

3. *Stream Plants of Fingerlings Made at All Seasons:* The average recovery rate is 2.5 per cent from 21 experiments and they ranged from 14.0 per cent to zero. Ten of the 21 experiments yielded less than a one per cent return while four of them gave zero returns.

One experiment in Oregon is of interest here in connection with the planting of fingerlings in cold mountain streams. A plant of 30,363 marked 3-4 inch rainbow fingerlings was made in the Clackamas River near Portland, Oregon in the fall of 1946. Just nine fish (.03 per cent) returned from this plant. The cost of rearing the entire lot had to be charged against these, which brought the cost to $28.53 per fish.

4. *Stream Plants of Legal-Sized or Catchables Made in Advance of the Angling Season:* In the 54 experiments reported, an average recovery rate of 28.6 per cent was determined. The range was from 82.0 to 2.60 per cent. The highest return consisted of a plant of two hundred 7- to 13-inch eastern brook trout planted in the Deerskin River, Wisconsin, a few days before the opening of the angling season (Williamson and Schneberger, 1943). Twenty-four of the 54 experiments produced returns of less than 20 per cent.

5. *Stream Plants of Legal-Sized or Catchables Made During the Open Angling Season:* These experiments, as would naturally be expected, yielded the highest average return of 41.3 per cent from 68 tests. The range extended from a high 92.2 per cent to a low of 1.0 per cent. Twenty-six of the 68 tests gave returns of less than 30 per cent. Highest returns are reported by Vestal (1954) from Rush Creek in Eastern California.

6. *Stream Plants of Legal-Sized or Catchables Made After the Close of the Angling Season.* This category is aimed at over-winter survival of trout. The mean rate is 16.8 per cent from 31 experiments. The range is from 88.6 to 0.20 per cent. Highest returns are reported by Trembly (1945) from Spring Creek, Pennsylvania. In this experiment five plants were made; one of large eastern brook, two of rainbow, and two with brown trout. Returns of from 47 per cent (eastern brook) to 88.6 per cent (rainbow) are reported. If these five recovery figures are eliminated, the mean drops to 8.9 per cent. Both Spring Creek, Pennsylvania and Rush Creek in California, are spring-fed streams not subject to drought and floods, temperature extremes, or to heavy snow and ice in winter, and high recovery rates from such streams are not surprising. Where more average stream conditions prevail, much lower recovery rates are evident in the data analyzed.

Mullan (1958) reports winter carry-overs of from a high of 9.4 per cent to zero from twenty separate lots of eastern brook trout stocked in the streams of Cape Cod. These findings, with others, confirm the fact that over-winter carry-overs of stocked trout are negligible.

CATCHABLE PROGRAMS

Having looked at survival rates of all size groups of trout, let's take a closer look at the expensive catchable or legal-sized, "put and take" programs. To keep alive the ancient art of angling and to meet continually increasing demands for bigger and better fish, federal and state hatchery workers almost knock themselves out each year to keep up with increasing pressures. As they accede to pressures, the pressure gets stronger for more and more "creel insurance," for that is precisely what it may be called.

Between 65 and 85 per cent of most state budgets for gamefishes are allocated for the propagation of trout. Do parallel percentages of licensed anglers fish for trout? Questionnaires obtained from anglers in California indicate that only approximately 30 per cent, in round figures, of California anglers fish for trout. Spending so much for the benefit of so few anglers seems out of balance, and out of the 30 per cent who fish for trout, who catches the catchables?

ANGLING SKILL A MAJOR FACTOR

Creel checks in California have demonstrated that between 65 and 75 per cent of those who try for catchables come away with empty creels, and I have no doubt but the same is true for other states. In other words, the bulk of those would-be anglers enticed with the sweet song of numbers of large trout being planted, come home emty handed. Another luckier group that makes up another 25 per cent, may take from one to five fish. These, with those who return with empty creels, total around 90 per cent. At the other end of the scale, we find a few expert anglers who come home with their creels well filled with the bulk of the planted fish. These of course, are in a minority. This select group of around 10 per cent in number, catch over fifty per cent of the catchables. Evans (1957) reports 3 per cent of the anglers fishing Crystal Lake in Southern California, took 30 per cent of the trout. In order to get a better distribution of the catch among anglers and to control the skill of the experts, Evans and others have recommended a drastic reduction of the daily bag limits. Another way to obtain better distribution of catchables is to plant them in lakes as is now being done in many states. A Nevada worker told the writer that it was his opinion that catchables should only be planted in lakes. If the lakes are of large size, the fish become widely dispersed which, in turn, reduces the concentration of anglers usually seen after the fish are planted in streams. Those surviving grow much larger and more like wild trout in their fighting ability.

TROUT AT A BARGAIN

Since 1948 over 4.3 million dollars has been expended in California on hatcheries. This has increased the production of catchable trout over 325 per cent. This is a large increase, but we doubt if the quality of the sport has been equally improved. In a way it might be said that by planting catchables we are competing directly with the operators of "fish-out" ponds where you catch your trout at so much an inch or per pound. The main difference is that it's cheaper to catch hatchery-reared fish planted by the state. Indeed, the state could save a lot of money by not going to the cost of planting catchables at all. They could set "fish-out" ponds aside at each hatchery where the angler, for a fee, could indulge his sport with assurance and where a 100 per cent return to the creel would be assured. This would have the practical advantage of having those anglers who catch catchables pay for them too. Now, many of us who prefer the quiet of a wild stream are taxed to support the catchable program without sharing its benefits. Assuming that catchables cost 20 cents apiece as they are planted, and assuming a 50 per cent mortality after planting, then each fish placed in the creel costs some 40 cents apiece. If your angling license cost you $3.00 then, theoretically at least, you have had more than your money's worth after you have caught eight of them.

Cases are on record where single families consisting of two adults and two children fishing on two licenses (no fee for children) have caught 60 (bag limit 15) catchable trout in one day. A good bargain this, where for a mere $6.00, $24.00 worth of trout are obtainable. But this is for only one day. If two bag limits are allowed each person each week, and if the season extends for twelve weeks, the same lucky couple can legally capture 1440 catchables having a net value of $576, and all for the token fee of $6. There is some consolation here, for probably this would not happen because analyses of creel data have shown that the best fishing for catchables in streams occurs immediately after the fish are planted, and falls away rapidly to zero within from 8 to 16 days following planting (Jensen, 1958). Thus unless our couple could stay right behind the fish planting truck, they would not be able to maintain their earlier predatory record.

HATCHERY TROUT UNFIT FOR SURVIVAL IN WILD WATERS

One of the reasons for the low survival of catchables in wild waters is that, being hatchery reared, they are poorly adapted to compete and survive with naturally propagated fishes that had to "learn the hard way." Being protected in hatcheries for from one to two years, spoon-fed, and accustomed to an easy life, when placed on their own they prove ill adjusted physically and genetically, and are unable to withstand the severe conditions of an independent existence. This has been proven by the appallingly low returns cited above and the fact that apparently a natural mortality rate of some 10 to 30 per cent occurs immediately after each plant for no apparent reason. Possibly the reason for low survivals is that we are planting strains of highly inbred, mongrel stocks which, because of their hatchery life, are physical misfits in wild environments. Decades of selection for hatchery conditions would certainly be poor preparation for survival in competition with wild trout. The evidence derived from survival studies cited here leads one to believe that the trout produced by present-day hatcheries are in no way the equal of wild trout, and the end product should be used principally for planting in fish-out streams or ponds or slaughtered and packaged for immediate consumption.

DELAYED MORTALITY

Where resident trout populations are already present in streams, losses of hatchery planted trout are often immediate and heavy as was noted above. This has been termed "delayed mortality." In seeking the causes of such losses, Miller (1958) tentatively indicated that they might result from competition with wild trout for living space or niches rather than for food, forcing the introduced fish to constant, excessive exercise resulting in death by either acidosis or starvation. This idea stems from the fact that he found significant differences in blood lactic acid levels between hatchery trout with and without competition from resident trout.

Observations on trout behavior made by using an underwater tank (Needham and Jones, In Press) indicate that trout are quite territorial, tending to occupy the same general areas for considerable periods of time. We know of one large brown trout that occupied the same hole in a beaver pond in Sagehen Creek for five years, remaining there despite heavy floods and other drastic environmental changes. It is rapidly becoming apparent that efforts to create fish "tenement districts" by dumping large numbers of trout into short stretches of stream, fail both because of lack of "living room" and ability to compete with resident forms already present. The excessive movements and resulting fatigue described by Miller could result from psychological frustration by virtue of crowding the fish into a new, strange, and limited environment.

QUALITY OF SPORT AND ANGLING ETHICS

The basic question here is this: is the quality of the sport improved regardless of where catchables are planted? I think not. To have to carry your own rock to stand on, to fish elbow to elbow with hordes of fishermen is not providing high quality sport. In the mad scramble to get their money's worth of catchables just dumped from the fish truck, the gentle art of angling becomes degraded and despoiled by greedy and unsportsman-like "meat" fishermen. Old-timers who are used to the wily, naturally propagated brown trout of the Deschutes or Ausable rivers, prefer fishing-room, if you will, with the bulk of the scenery undisturbed by hundreds of eager-eyed anglers using hamburger, liver, or cheese for bait. As the plantings of catchable trout increase, the quality of the sport decreases. In following the fish planting truck are we properly indoctrinating our youth in the principles of true sportsmanship and knowledge of proper angling ethics? Certainly it makes no difference whether a trout is caught on a dry-fly or a worm, but it is questionable whether our sons can learn proper stream etiquette by standing in line at a fish-out pond or crowded by hordes of anglers on the edge of a fish-out stream. The planting of catchables is the cause of the crowding. On a stream where no catchables are planted you may see a lot of anglers but usually not elbow to elbow and the practice of stream ethics there reflects a higher standard of angler effort. You seldom see fist fights, and if you find an angler on a small pool ahead of you, you respect his rights and go around it to the next likely spot.

The modern tendency of many states continually to pyramid catchable trout programs at the expense of habitat improvement or research seems indefensible on a long-term basis. We have been kidding ourselves into believing that we can improve the quality of the angling by increasing the supply of fish above and beyond those provided by natural reproduction. The quantity of fish has increased while the quality of the fishing has sadly deteriorated. As one Southern California angler put it: "The truck arrives at 11:00 a.m. with hordes of cars following, the stream is fished out by 2:00 p.m. and dry by 4:00 p.m. if somebody decides to irrigate."

NATURAL PROPAGATION

A good idea of just how effective natural propagation can be is illustrated by research done at the Sagehen Creek Wildlife and Fisheries Project located near Truckee, California, in cooperation with the California Department of Fish and Game A creel census operated on the upper five miles of Sagehen Creek over the past six years has shown that this small stream produces roughly between 1600 and 3200 trout weighing between 162 and 287 pounds each year to anglers—all of which come from natural propagation, since stocking of hatchery fish was stopped there in 1951. By annually sampling fish in the stream itself in a series of ten short sections by pumping and draining, estimates of total fish available for the catching have been made The exploitation rate of fish four inches and up in length has averaged below 45 per cent of those available each year. Catches have averaged between 1.08 and 1.88 fish per angling hour which is indicative of good fishing provided solely by natural spawning. There is good escape shelter and the exploitation rate evidently permits survival of adequate breeding stocks each year. These are providing all the trout necessary for the ''room and board'' in Sagehen Creek. Many waters like Sagehen Creek that do not need hatchery fish at all are still being stocked.

Recent trends towards setting aside certain lakes, streams or sections of streams for fly-fishing only or where ''catch-and-put-back'' areas have been designated, will do much to improve the quality of the angling. If artificial lures and barbless hooks are required in such areas, a lot of fishermen will be able to have much excellent sport, including the experts. And that basically is what we are trying to provide.

DESIGNATION OF CATCHABLE WATERS

Fish and Game officials know that from 75 to 85 per cent of all trout creeled originate from natural spawning, not hatcheries. This being the case and since natural propagation is carrying the main burden so far as angling is concerned, why not give more funds for research and experiment to aid and abet this process? Habitat improvement to increase natural spawning seems to us to offer a new and largely unworked field. I refer here not to the removal of log jams and other barriers to spawning migration of anadromous fishes, which is a useful tool, but rather to the details of actually creating new and greater expanses of spawning beds in suitable, accessible areas. We have no reports of studies along this line except in a few isolated areas. If work is started along these lines, there will be less money for rearing catchables. This means a ceiling must be set for the hatchery program that will leave sufficient funds for badly needed new and basic attacks. If such a ceiling is to be set it will first be necessary to designate certain lakes, whole streams, or sections of streams as ''fish-out'' or ''catchable trout'' areas and determine the number of fish that will be required annually to stock these waters. The water area of suitable habitat will never be higher than it is today for the planting of catchables. It is rapidly becoming less as water use becomes greater so that in the long pull over the years a gradual decrease in the catchable program can be forecast.

DESIGNATION OF "NATURAL FISH" WATERS.

After designation of the "catchable" waters, all other lakes, streams or sections of streams might be declared "natural fish" waters in which most of the reliance for providing fishing will be placed on natural propagation alone. I use the word "most" advisedly. It is well known that in some lakes lacking suitable spawning inlets or outlets, the planting of fingerlings may help to maintain angling and stocking of such waters must of necessity be continued. Where "winter-kill" of all fish life occurs, re-stocking is the only remedy. The same would apply to streams denuded of fish life by pollution, flash-floods or other causes. Streams designated as "wildfish streams" would never require stocking except where catastrophes occur. Stocking would only be used where it has demonstrated its effectiveness.

STOCKING FOR REPRODUCTION SUCCESSFUL

Stocking game animals or fishes for the purpose of establishing self-sustaining populations is good, and its value as a management tool has been proven many times. The introduction of brown trout from Europe and pheasants from China is proof of this principle. But where all suitable habitat has already been stocked, the problem then becomes one of proper use of the hatchery or game-farm products in areas already containing "wild" populations. Thousands of streams and lakes that are now producing fine fishing were barren of fish originally. For this we must thank the early-day fish culturists who saw to it that suitable species were established. But that day is gone now and there are no more barren lakes or streams available for stocking. How long are we going to let wishful thinking and the fond belief in hatcheries continue to bar further progress? The application of facts derived from research will provide the future answers.

In closing I am reminded of the farmer who was asked if he could play the violin. He replied, "I don't know, I never tried." In fisheries management there are many things that we don't know and have never tried. The blind faith displayed by the angling public in hatcheries must be replaced by broader concepts disseminated from more detailed knowledge of the natural behavior and survival of fishes. We are still in the "Model T" days in so far as our understanding of the physiology and genetics of gamefishes is concerned.

It is easy to get millions for hatcheries but hard to get even a pittance for research. How long can such a single "yard-stick" bar further progress? If the angling needs of the future are to be met, if we are to obtain the most from our shrinking habitats and show parallel progress with other fields of endeavor, a drastic change in attitude and programs is essential. Only then will we be able to live in a state of piscatorial rectitude.

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DISCUSSION

CHAIRMAN SCHEFFER: Dr. Needham has spoken to us of objectives, standards, and ideals. I like to hear a man speak up for ideals because I think that the idealist, far from being the impractical person that we often think of him as, is actually one of the most realistic creatures among us.

Are there comments on Dr. Needham's talk in the last five minutes available to us?

DR. CLARENCE COTTAM: What would be the comparable percentage of fish produced in the wild, but which have been tagged, and then turned loose? Would that be comparable at all?

DR. NEEDHAM: That would be comparable.

Unfortunately, we have not the data on that. The man who has done the most work, Dr. Richard Miller, is not here.

There are a number of data that are available on the experimental fish on the comparison of wild fish, but we have not accumulated the mass data that would be necessary for this chart. It would be very nice to show the comparison for wild fish under two experiments run under the same type of conditions. I wish I had it.

MR. ALBERT HAZARD [Pennsylvania Fish Commission]:

Paul, as you know, I agree with your philosophy and we should maintain fishing where we can by natural means.

But here in the East, with our growing population, with the growing pressure, I am now quite convinced that we cannot rely on natural reproduction, that even if we improve all of our streams and lakes to the limit, we still will not be able to provide fishing, or adequate fishing recreation.

I did not say fish catches. I believe there are ways in which we can utilize our hatchery production to better advantage than we are now doing.

I would go along with you that we ought to do most of our stocking in the poorer streams, the marginal streams, where we do not have the competition from the wild fish. We will get better returns, I am sure. They will also spread the fishing opportunities over the State.

The other idea is to limit the kill. This past year in Pennsylvania, we had a stream in which fishing was permitted, that is, unlimited fishing during the season. One could catch all the fish he wanted to, but he could not kill any in that branch of Youngman's Creek.

That experiment has proven out very well, and will be continued this year. At the end of the season, when we know the population we have through stocking, it is likely we will also install a trophy fish size as they have on the fish for fun streams, in the Great Smokies National Park. I hope the biologist who is associated with that program is present and will comment also.

DR. NEEDHAM: I want to compliment you, Al. I had that also in my paper, but time was pressing me so I did not mention it.

But I think you are a hundred per cent right. We should be emphasizing sports values, and one way to do it, will be told to you by Mr. Wallace who is coming up to the microphone.

MR. WALLACE [National Park Service]: For about four years down in the Great Smokies Mountains National Park, we have had an experiment which has been conducted in cooperation with the U. S. Fish and Wildlife Service.

We started out with two streams that were for fishing for fun only, fish all you want but return the fish.

We have expanded that into four streams now. These four streams are open all year around rather than just during a limited fishing season. Down there they have found that in these streams, the anglers are able to catch up to 11 fish per angler-hour, as compared in nearby streams where they can keep the fish.

There they only get about a half a fish per hour.

So it has increased the sport, the recreational aspect, and it has met with a great deal of public enthusiasm in that area.

Now, it is not a thing that is going to work in all waters, but it is one possible solution. Al Hazard, of course, proposed this idea several years ago, and it came out first in *Sports Afield*, and during the past year there have been a couple of follow-up stories in *Sports Afield*, about the first applications of this theory.

DR. NEEDHAM: Thank you, Mr. Wallace. I think if we get to the point where we can really emphasize the sport value, the intangible recreational values, the joy of being on the stream and try and educate our customers to get away from the meat fishing, this setting aside of these streams as Dr. Hazard and the last speaker mentioned. Then by fiy-only streams with barbless hooks, I think we can create a lot of good fishing, a lot of fishing of high quality, and we can get away from the rather disgraceful, greedy attitude of the meat fishermen following planting trucks and degrading an otherwise noble sport.

TECHNICAL SESSIONS

Wednesday Afternoon—March 4

Chairman: CASEY E. WESTELL, JR.
Forest and Wildlife Ecologist, American Box Board Company, Filer City, Michigan

Discussion Leader: RALPH T. KING
Roosevelt Wildlife Forest Experiment Station, Syracuse, New York

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FOREST AND RANGE RESOURCES

THE EFFECT OF TUBOCURARINE CHLORIDE ON THE RED DEER, *CERVUS ELAPHUS* (L.)

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In literature there are many data concerning the influence of curare on domestic animals (Booth, N. H., 1956a,b; Bovet, D., 1955; Jones, L. M., 1950; Smithcors, J. F., 1956), but there are no data on the influence of curare on red deer.

The purpose of the present experiments was to extend our knowledge of the action of curare on one more species, and also to investigate the possibility of using tubocurarine chloride in red deer control (Jaczewski, Z., Krzymowski, T., 1957).

MATERIALS AND METHODS

The experiments were made on three red deer does and seven red deer stags. The animals, of different age, were fed on oats, clover, carrots, beetroot and branches of trees. One day before the experiment the older animals (age—over one year) were closed in a small enclosure. Next day, each animal was tied to the fence in a standing

[1]In the absence of the authors, this paper was read by title.

position, and injection was given immediately. This operation required from 4 to 20 minutes; *i.e.* average time 9.2 minutes, counting from the moment of entering the small enclosure to the moment of injection. After the injection each animal was allowed to run freely into a large enclosure.

Only two small one-year-old stags and two small does were so tame that they were not kept in the small enclosure before the injection. The catching of these tame animals took only a few seconds; after the injection these animals did not run away, as did all the older ones, but remained with the people.

When, as a result of the action of tubocurarine chloride, the animal fell down, it was weighted.

The drugs used were: tubocurarine chloride and prostigmine (dimethylcarbamicum m-hydroxyphenyltrimethylammonium methylsulfuricum).

COURSE OF THE EXPERIMENTS

1. On October 15, 1958, tubocurarine was administered to a red deer doe, which weighed 108.5 kilograms. This doe fell down 19 minutes after an intramuscular injection of 30 milligrammes of tubocurarine chloride and died 40 minutes later—59 minutes after the injection.
2. On November 3, 1958, a red deer stag, which weighed 141 kilograms, fell down 27 minutes after an intramuscular injection of 20 milligrammes of tubocurarine chloride and died 106 minutes later—133 minutes after the injection of tubocurarine.
3. On November 11, 1958, the red deer stag "Jurek", which weighed 193.5 kg, fell down 55 minutes after an intramuscular injection of 10 mg of tubocurarine chloride and stood up 125 minutes later—180 minutes after the injection of tubocurarine.
4. On November 13, 1958, the Red deer stag "Raczy", after an intramuscular injection of 5 mg of tubocurarine chloride manifested only symptoms of weakness and trembling. These symptoms began about 60 minutes after the injection and ceased about 35 minutes later.
5. On November 17, 1958, the same stag "Raczy", which weighed 118.5 kg, received tubocurarine again. It fell down 12 minutes after an intramuscular injection[1] of 8 mg of tubocurarine chloride and stood up 181 minutes later—193 minutes after the injection.
6. On November 18, 1958, the stag "Jurek" received tubocurarine again. It fell down 59 minutes after an intramuscular injection of

[1]Part of this injection, by accident, might have been intravenous.

12 mg of tubocurarine chloride. Eight minutes later it was given 0.95 mg of prostigmine intramuscularly. Seven minutes later another intramuscular injection of 0.95 milligrammes of prostigmine was given. It stood up 22 minutes later—96 minutes after the injection of tubocurarine.

7. On December 9, 1958, the stag "Jurek", which weighed 193 kilograms, fell down 36.5 minutes after an intramuscular injection of 15 milligrammes of tubocurarine chloride; 22 minutes later it was given 2.25 milligrammes of prostigmine intramuscularly. It stood up 82 minutes later—140.5 minutes after the injection of tubocurarine.

8. On December 11, 1958, the stag "Raczy", which weighed 119 kilograms, fell down 13 minutes after an intramuscular injection of 11 mg of tubocurarine chloride; 11.5 minutes later it was given 2.25 mg of prostigmine intramuscularly; 20.5 minutes later another intramuscular injection of 1.5 mg of prostigmine was given. It stood up 154.5 minutes later—199.5 minutes after the injection of tubocurarine.

9. On December 13, 1958, the stag "Sznurus", which weighed 95 kilograms, fell down 5 minutes after an intramuscular injection of 5 milligrammes of tubocurarine chloride; 6 minutes later it was given 2.25 milligrammes of prostigmine intramuscularly. It stood up 71 minutes later—82 minutes after the injection of tubocurarine.

10. On December 16, 1958, the stag "Jasio," born 1958, which weighed 61 kilograms, manifested no symptoms during 77 minutes after an intramuscular injection of 2 milligrammes of tubocurarine chloride. Therefore after 77 minutes another intramuscular injection of 4 milligrammes of tubocurarine chloride was given. It fell down 31 minutes after the second injection of tubocurarine; 5 minutes later it was given 2 milligrammes of prostigmine intramuscularly. It stood up 184 minutes later—297 minutes after the first injection of tubocurarine, and 220 minutes after the second injection of tubocurarine.

11. On December 16, 1958, the stag "Lejek," born 1958, manifested no symptoms at all after an intramuscular injection of 3 milligrammes of tubocurarine chloride.

12. On December 30, 1958, the stag "Lejek," which weighed 66.5 kg, fell down 57.5 minutes after an intramuscular injection of 4 mg of tubocurarine chloride; 14.5 minutes later it was given 1.75 mg of prostigmine intramuscularly. It stood up 4 minutes later—76 minutes after the injection of tubocurarine.

13. On January 7, 1959, the stag "Jurek," which weighed 192.5 kilograms fell down 47 minutes after an intramuscular injection of 20 milligrammes of tubocurarine chloride; 13 minutes later it was given 5 milligrammes of prostigmine intramuscularly. It stood up

276 minutes later—336 minutes after the injection of tubocurarine.

14. On January 16, 1959, the stag "Raczy," which weighed 116 kilograms, fell down 29.5 minutes after an intramuscular injection of 12 milligrammes of tubocurarine chloride; 25.5 minutes later it was given 7.5 milligrammes of prostigmine intramuscularly. It stood up 9 minutes later—64 minutes after the injection of tubocurarine.

15. On January 19, 1959, the stag "Jurek" fell down 27 minutes after an intramuscular injection of 20 milligrammes of tubocurarine chloride; 11 minutes later it was given 6.5 milligrammes of prostigmine intramuscularly; 6 minutes later another intramuscular injection of 6.0 milligrammes of prostigmine was given. It stood up 10 minutes later—54 minutes after the injection of tubocurarine. The observations were then finished, but it was stated that, 263 minutes later this stag was lying in a normal position, its head up, but unable to rise. After another interval of observation, 105 minutes later the stag was running normally—422 minutes after the injection of tubocurarine.

16. On February 7, 1959, the stag "Miki," which weighed 129.5 kilograms fell down 36 minutes after an intramuscular injection of 15 milligrammes of tubocurarine chloride; 16 minutes later it was given 5 milligrammes of prostigmine intramuscularly. It stood up 248 minutes later—300 minutes after the injection of tubocurarine.

17. On February 10, 1959, the red deer doe "Sylwia," which weighed 59.5 kilograms fell down 25 minutes after an intramuscular injection of 5 milligrammes of tubocurarine chloride; 11 minutes later it was given 5 milligrammes of prostigmine intramuscularly. It stood up 7 mintes later—43 minutes after the injection of tubocurarine.

18. On February 10, 1959, the red deer doe "Ina," which weighed 45 kilograms, fell down 59.5 minutes after an intramuscular injection of 3 milligrammes of tubocurarine chloride; 17.5 minutes later it was given 3 milligrammes of prostigmine intramuscularly. It stood up 5 minutes later—82 minutes after the injection of tubocurarine.

All the most important of the above data are given in Table 1.

DISCUSSION OF RESULTS

Symptoms of tubocurarine chloride action begin with muscle trembling and lifting of the tail. Afterwards the animal falls down, or in rare cases, lies down. Then, during some minutes, it holds up its head, lying on its sternum in a normal position. In this state the animal is unable to rise but holds its head up, normally. It seems, therefore, that the muscles of the legs are more susceptible to tubocurarine than those of the neck. Subsequently the animal is unable to support its

TABLE 1. THE MOST IMPORTANT DATA OF THE PARTICULAR EXPERIMENTS

Sex	Weight in kilograms	Tubocurarine dose in milligrams	Interval between injection and fall of the animal in minutes	Prostigmine dose in milligrams	Interval between injections of prostigmine and tubocurarine in minutes	Interval between injection of tubocurarine and standing up of the animal in minutes	Interval between injection of tubocurarine and death of the animal in minutes
♀	108.5	30	19	....	....	....	59
♂	141	20	27	....	....	....	133
♂	193.5	10	55	....	....	180	....
♂	118.5[1]	5	....	....	....	....	....
			weakness and muscle trembling				
♂	118.5	8	12	....	....	193	....
♂	193.5[1]	12	59	0.95 : 0.95	67 : 74	96	....
♂	193	15	36.5	2.25	58.5	140.5	....
♂	119	11	13	2.25 : 1.5	24.5 : 45	199.5	....
♂	95	5	5	2.25	11	82	....
♂	61	2 : 4	108 : 31	2	113 : 36	297 : 220	....
♂	66.5[1]	3	....	....	....	....	....
♂	66.5	4	57.5	1.75	72	76	....
♂	192.5	20	47	5	60	336	....
♂	116	12	29.5	7.5	55	64	....
♂	192.5[1]	20	27	6.5 : 6.0	38 : 40	54/422/	....
♂	129.5	15	36	5	52	300	....
♀	59.5	5	25	5	36	43	....
♀	45	3	59.5	3	77	82	....

[1]This stag was not weighed on that day.

head, and it falls down lying flat on its flank. This moment is noted in the above records of the experiments, as the moment of falling down.

The first stage, of lying with the head up, was not observed in the following experiments: No. 1, 2, 3, 4, 11, 17. Of course, experiments No. 4 and No. 11 cannot be taken into consideration, as in these cases, there were no symptoms of tubocurarine action at all. This stage of lying in a normal position with the head up, but unable to rise, lasted from 15 to 0.5 minutes; *i.e.* average time 7 minutes.

When the animal is lying flat, it tries to rise when somebody comes near, but this effort results in muscle trembling only. A lying animal was able, in several cases, to move its ears. It seems therefore, that the ear muscles are less susceptible to tubocurarine than the muscles of the legs and neck. Later, of course, tubocurarine chloride affects muscles involved in respiration and, finally, the diaphragm

When the action of tubocurarine ceased, the restoration of respective muscular activities followed, but in a reversed order. First the animal was able to raise its head and to lie in a normal position and, after a few minutes, it stood up.

In some cases only (No. 5, 9, 14, 17, 18) the animal stood up immediately from flat lying to a standing position.

Characteristic of the tubocurarine action is its rapidity. The animals fell down abruptly and rose also in the same abrupt manner.

The moment of paresis of the muscles of the legs occurs very suddenly, as also the moment of paresis of the muscles of the neck. The recovery is just as sudden.

It seems that the dose of tubocurarine and its effect depend on the behavior of the animal before the injection. When the animal is tame and keeps quiet, the dose has to be heavier. When the animal is very nervous and tired from muscular exercise, the dose used may be much smaller. This was particularly distinct in experiments Nos. 9, 10, 12, and 17. The smaller animals, which were very tame and kept very quiet all the time, needed nearly the same dose as the two-year-old and much heavier stag "Sznurus," which was very nervous.

When the action of tubocurarine begins, often a simple frightening of the animal suffices to bring about an abrupt attempt of muscular effort followed by an immediate falling down of the animal.

The beginning of the tubocurarine action starts sooner (experiments No. 5, 8, 9) and is usually more rapid when the animal is very nervous (stags "Sznurus" and "Raczy"). This seems to be a more reasonable explanation than the supposition that part of the injection might have been intravenous.

It seems also, that artificial respiration, recommended in curare intoxication in man, is not effective in case of red deer, because it frightens the animal and, a series of unsuccessful nervous impulses which follow make suddenly worse the animal's condition.

The above may, perhaps, be explained as being the result of an increased acetylocholine production in the neuromuscular transmissions, which thus become more susceptible to tubocurarine chloride.

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SOME CONSIDERATIONS CONCERNING THE EMERGENCY WINTER FEEDING OF WILD TURKEYS IN NORTHERN STATES

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Pittsburgh Press, Pittsburgh, Pennsylvania

For many years, winter feeding of wild turkeys and other game has been an accepted and expensive management practice in Pennsylvania. A large part of this activity and expense during many winters and in many counties may constitute more of a public relations gesture than a proven game measure. Unfortunately, insufficient study has been made of the subject to date for anyone to decide positively whether winter feeding is necessary or unnecessary, desirable or undesirable. It does seem safe to assume that additional knowledge will at least permit modifications of techniques, materials, and procedures which may accomplish just as much at far less cost than at present. Pennsylvania's winter feeding program has been costing between fifty and ninety thousand dollars annually.

The arguments for winter feeding are about as follows:

(1) During periods of deep snow the wild turkey is unable to secure natural foods and may die of starvation or succumb to predation or disease because of the weakened condition.

(2) During years of generalized mast failures, artificial feeding is necessary to prevent starvation.

(3) Unless the birds emerge from the winter in good physical condition, reproduction will be curtailed.

(4) In the past, sportsmen have been led to believe that winter feeding is necessary and desirable and therefore expect the Game Commission to continue the program indefinitely.

An analysis of these four factors in light of present knowledge and the findings of research would indicate considerable doubt about the validity of the arguments. Point one indicates that deep snows deprive wild turkeys of their natural foods. This is rather obviously not true, although deep snows do make some foods unavailable and do restrict the feeding range of the birds. However, in Pennsylvania, West Virginia, and Virginia it has been found that only when snows become several feet deep do turkeys really face starvation. Under more normal conditions they are unbelievably capable of finding food.

In the first place, they have the ability to scratch through twelve to fifteen or more inches of snow if it is not crusted. This permits them to reach the food of the forest floor, which appears to be sufficient at all times to prevent starvation. When snows are fifteen inches to two feet deep, they often depend upon deer to aid them in reaching the ground. The birds follow the deer in their feeding areas and utilize the bare spots created by them while pawing for food. A turkey will actually stand by patiently while its benefactor paws a hole in the snow and then jump in immediately when the deer steps back to see what it has uncovered.

Many food items are found above the snow and utilized readily. Among these are wild grapes (*Vitis* sp.) still hanging as dried fruit high on the vines throughout the winter; dried fruit of blackberries *(Rubus allegheniensis)*; greenbrier *(Smilax)*; and Japanese honeysuckle (*Lonicera japonica*) which are persistent, and ocasionally others. Non-fruit items eaten as emergency food are lichens and moss from the bark of trees and logs; fern particles, rhododendron leaves *(Rhododendron maximum)*, hemlock needles, leaves of greenbrier and Japanese honeysuckle, and a great variety of buds, especially beech.

But more important than these foods are the nutritive materials the birds find in springs and spring runs. Even during the coldest weather, most of these wet areas stay open, and here the turkey secures various kinds of green forage (grasses, violet, strawberry, hepatica, sedges, and some semi-aquatic plants). Also mast, tubers and rootlets are usually available along and in the small runs. And finally, a fair abundance of animal foods is regularly available in these springs, such as aquatic insects and their larvae, crayfish, salamanders, snails and earthworms.

And finally, there are often bare areas blown free of snow on open points of mountains and ridges.

Therefore, it is doubtful whether a Pennsylvania wild turkey would ever be completely foodless even under extreme conditions. And on normal winters, there is little reason to believe that the birds would suffer without any supplemental food in any part of the State.

Point two suggests a mast failure on certain years and a failure of the food supply. This supposition also needs careful analysis. The study has revealed that a mast crop failure as ordinarily designated does not necessarily indicate a mast failure for wild turkeys. This is because the wild turkey will utilize almost any seed or fruit produced in the forest and is not necessarily dependent upon the more common mast crops such as acorns, beechnuts, and hickory. Wild turkeys compete with squirrels, bears, deer, and many other animals for these larger seeds, but share many of the smaller seeds and fruits only with mice, songbirds, and perhaps grouse. This latter competition is seldom sufficient to deprive the turkeys of an ample supply. Because this large bird will and does eat almost anything in the line of seeds and fruits, green vegetation, and insect life, a true mast failure is hardly possible for it in the mixed forests of Pennsylvania. As long as the turkey can get to the forest floor, it will not starve over winter. *If the forest floor is covered with three to four feet of snow, it matters little whether a mast crop is present or not.*

Point three referred to the possibility that wild turkeys might emerge from the winter in poor physical condition if not fed artificially and this might adversely affect reproduction during the spring and summer.

Experiments conducted by the writer at the Loyalsock Experiment Station showed that reproduction of the ring-necked pheasant was not reduced by winter fasting and the attendant severe losses of body weight. The only noticeable effect was a delay in the start of egg production. Otherwise, the fasted birds produced more eggs during the laying season, had as high fertility, and even better hatchability than the unfasted control group. There is good reason to believe that the wild turkey would respond to this stress in much the same way.

The final point (4) favoring winter feeding relates to the public relations aspect of the program. Sportsmen have been sold on its desirability and would perhaps resist a cessation of the practice. In fact, many sportsmen conduct their own winter feeding activities, with feed purchased either by the Commission or by themselves.

Certainly this aspect must receive careful consideration, but it should not prevent a thorough evaluation of the program as it now exists. If research can prove that the program can be modified to save money, which might be used to better advantage elsewhere without endangering the over-wintering stock, then public sentiment should not obstruct the move. Sportsmen generally are intelligent humans who are capable of evaluating data and facts, and who are willing to make changes for the better when convinced that it is the sensible thing to do.

In addition to the discussion already presented concerning the need for artificial feeding of turkeys in winter, there are several other pertinent points which should be listed. These are largely of a negative nature—that is, they suggest a possible lack of need for winter feeding and even suggest possible undesirable aspects of the program.

The first is that during the precolonization years, and for perhaps two hundred years following the arrival of the Pilgrims and Puritans, wild turkeys existed in the region now known as Pennsylvania by the tens of thousands. Records indicate that winters were regularly more severe and snow deeper at that time than now, and yet no winter feeding was necessary for the survival of turkeys as far north as southern Maine and southern Ontario.

With virgin forests everywhere there was probably a great abundance of mast, but this again was not available during long weeks of heavy snow cover. Why might not the present wild turkeys survive as well as its ancestors of two or three hundred years ago without assistance from man? Or should it be assumed that the modern turkey is not as hardy as the original bird?

It will be impossible ever to answer the question just posed, but much is known concerning the hardiness of the twentieth century turkey. Experiments conducted at the Loyalsock Wildlife Experiment Station with farm-reared wild turkeys proved this beyond doubt. Four of these birds were placed in the climatic chamber there and exposed to a constant zero temperature until they died. Two of the birds were also subjected to a six-mile-per-hour wind. They had no food or water during the entire course of the test. The two birds in the wind lived seven and nine days respectively. The two out of the wind survived eleven and sixteen days. A single check bird held in an unheated room outside the climatic chamber survived twenty-four days without food or water.

Two more of these pen-reared turkeys were confined in an outdoor pen during mid-winter without food. These lived nine and nineteen days. There is good reason to believe that the true wild bird would be even more hardy than this pen-reared stock. Just as a note of interest, the females exhibited a greater hardiness than the males, which was found to be typical of all polygamous species tested (ruffed grouse, ring-necked pheasant, mallard duck). On the other hand, the males of monogamous species (bobwhites and gray partridges) proved the more resistant to stress.

Observations in the wild and at the State Game Farm have substantiated this experimental evidence. Leon P. Keiser, Superintendent of the State Wild Turkey Farm, witnessed an astounding demonstration of this. During the 1935-36 winter, about 1000 of his birds were being held in a pen where a natural stand of Virginia pine formed the roosting cover. During one of the more severe storms of the winter when about 30 inches of snow fell and temperatures remained almost constantly below zero, these birds never left their roost to feed for eight days, even though food was placed close by. With a break in the weather at the end of the eight days, the birds descended, ate voraciously, and seemed little the worse for their self-imposed fast.

Glover (1948), in following the activities of several flocks during the 1946-47 winter in West Virginia, found that turkeys stayed on the roost for two to four days during severe storms. Mosby and Handley (1943) relate how turkeys in Virginia during the period from January 23, 1940, to February 6 spent almost the entire time in the trees. During this period, when 18 to 26 inches of snow fell, Japanese honeysuckle thickets provided the only food taken by the birds. In spite of the restricted movement, reduced food supply, and exposure to weather and predation, few, if any, birds were known to have been lost during the two weeks.

This is typical behavior of the wild turkey during periods of extreme stress and again illustrates its ability to withstand long periods of semi-starvation. Further proof is provided by the lack of reports of dead or dying birds since the winter of 1935-36. During a number of the different winters since that time, deer have starved by the hundreds and even by the thousands in the same areas where the turky appeared to survive without loss. The 1935-36 winter was outstandingly severe during the past thirty-five or more years. During that winter a number of dead specimens were found, but no detailed analysis of the cause of death was conducted. It seems logical to assume that at least a part of this mortality could be directly attributed to the combination of adverse meteorological factors.

Bailey (1955), in speaking of winter starvation, states: "In West Virginia, snows of the type to cause turkey starvation have occurred twice during the last eight years—in the winters of 1946-47 and again in 1954-55.

"In 1947, heavy snowfall did not occur until the last week of January. For weeks practically no melting occurred and snow accumulated to a depth of 50 inches in many areas. Large patches of bare ground did not appear until late March and early April. During March of that year a few turkeys that had died of starvation were examined by Commission personnel. Reliable reports of other losses were received.

"In 1954, snow began accumulating in mountainous areas before Thanksgiving. From that time until the first week of January, 1955, there was no substantial thaw. During early January, the ground was free of snow for a few days, but bitter, arctic-like weather resumed with snow accumulating to 30-inch depths. It remained until the second week of March. During most of February the snow was heavily crusted, sometimes enough to support an auto. At one time there were three separate crusts.

"During the time of snow cover, rumors spread that many wild turkeys were dying of starvation. Only one turkey that had died of starvation reached my possession and it was the carcass of an extremely old bird that probably had perished as a result of old-age weakness.

"In both of the critical winters mentioned, substantial survival occurred in areas where conditions were worst and where no artificial feeding was, or could be, carried out.

"Apparently, turkeys perishing during critical snow periods are the very young, the very old, or those diseased or weakened from other causes."

A light winter loss of turkeys is probably a very desirable thing. Especially where states are stocking large quantities of farm-reared birds, there are bound to be individuals of inferior physical quality and other individuals carrying diseases or defective in some manner. The winter culling of these "unfits" is unquestionably beneficial in terms of wild turkey management.

Because of the great variation in climate, forest type, topography, and total food supply in different parts of Pennsylvania, the winter feeding programs logically should be related to geographical regions. Only during the most exceptional winters is there a likelihood that any emergency feeding would be required in many counties. The relatively safe area may well coincide with the distribution of the oak-hickory forest type which includes the southern two-thirds to three-fourths of the State. Bailey (1955) found this to be true for West Virginia. He states that during the two severe winters of 1946-47 and 1954-55, losses occurred only in beech-birch-maple forests of high elevations. He was unable to uncover any records of turkeys having starved in oak or oak-pine forests, which generally occur at elevations of less than 3,500 feet. In Pennsylvania, deep, persistent snows and consistently low temperatures are fairly well confined to the one or two rows of counties lying next to the New York border. The birch-beech-maple forests of these counties produce considerably less mast than the oak-hickory type to the south, and competition for food by deer is, at the same time, much greater in the northern tier. If further study proves the desirability or need for emergency winter feeding anywhere in the State, this certainly will be the area most benefited.

With the kind of feed (ear corn) and the type of feeders presently used, a very small percentage of the total amount fed is actually taken by wild turkeys. Statewide it is probably well under ten per cent, probably much less most places. The consumption of the remaining ninety per cent or more by deer, squirrels, and miscellaneous animals is of questionable game management value. In the case of deer it may merely be aggravating a condition of overpopulation and range destruction. There is no positive evidence that squirrels need this supplement, even though they readily respond to the "free lunch" invitation. There is a possibility of using a smaller grain or seed which might be ignored by deer and squirrels but acceptable to turkeys. Or new-type feeders might be developed which would prevent the major losses to other animals, but still serve the turkeys. Either method should reduce the total cost considerably but in no way reduce the effectiveness of the turkey feeding effort.

Two other considerations might be mentioned in relation to the winter feeding program. The first is that there is some suspicion that the truly wild flocks are so wary by nature that they would never approach many of the different types of feeders now in use. Wilderness birds may detour widely around an ear of corn lying on the ground and even refuse to take grain scattered by squirrels or other animals several feet from a feeder but will not approach closely enough to take the grain directly.

Also, the concentration of birds around a feeder, when they do respond to the feed, may present a possible danger from disease and predation. Ordinarily predation is inconsequential, but the possibility of the spread of blackhead and other diseases of adult turkeys is a potential menace since the birds are usually feeding from the ground. Thus, the feed can easily be contaminated by their own droppings.

In conclusion, it would appear, from evidence presented, that Pennsylvania could revise its wild turkey winter feeding program with a considerable savings of money and effort without endangering the future of this grand bird. It seems probable that the money thus saved could be utilized for other management measures which would result in greater numbers of wild turkeys and increased recreational opportunity.

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DISCUSSION

DISCUSSION LEADER KING: One of the statements in the paper is so contrary to what we commonly believe, and, in fact, to what I have heard stated in other sessions at this meeting in the last two days, that I want very much for Dr. Latham to expand a little on these experimental results with pheasants that had fasted during the winter and the effect on the following spring's reproduction.

DR. LATHAM: Our experiment involved wild-trapped pheasants, and we had 25 hens in a pen with a sufficient quantity of roosters. These birds were fasted at one time for 36 days without any food whatsoever. Some of these birds lost as much as 55 per cent of their body weight and the average was around 45 per cent. At the end of 36 days they were given feed, brought back part way in their weight, and then were given an additional week without food, so that by the end of March we had given them a pretty rough winter. These birds were approximately ten days late in beginning to lay eggs, but, as I stated, their total production, hatchability, and fertility of eggs and viability of the chicks were actually better than the controls, which were not starved at all. I think it is very good evidence, at least in this one instance, that the bird certainly was not hurt by starvation which would be far more severe than they would normally face in the wild. I feel confident that the wild turkey and the pheasant are close enough in their physiology and general characteristics that we can almost assume that this would apply there as well.

I know from experience with farm-reared wild turkeys that, if they go into the breeding season too fat, fertility and reproduction are reduced somewhat.

DR. BUECHNER [State College of Washington]: I would just like to make a comment. I don't think it is generally known and I don't think these data are published, that similar studies to the one described have been carried out at one of the game farms on pheasants in the State of Idaho with exactly the same sort of results.

DR. SWANK [Arizona]: Roger, did West Virginia carry out its feeding program during the last few years as Pennsylvania did? I believe that at one time West Virginia carried out its program according to Glover's recommendation only when the snow had reached 15 inches and during very severe periods. What were the comparisons of population of the two states and how did the birds in the two states survive the winter?

DR. LATHAM: I will have to be somewhat hypothetical in my answer because I didn't have figures for the two, but as an educated guess, the Pennsylvania Game Commission during any winter feeds almost regardless of the conditions. When mid-December or late December comes, the feeders are full whether the ground is bare or whether there is two feet of snow.

West Virginia has been doing much as Wendell says, only putting out feed when they felt it was necessary and West Virginia does not reach a large proportion of its turkey population, as I understand it. There are 5,000 foot altitudes there, and roads are practically impassable. I know that during certain winters at least they never did get back into many of the back areas where there were quite a lot of turkeys.

From having hunted in both states and from acquaintance with the turkey biologists of West Virginia, I believe that over most of this high mountain area where the least feeding is done and where the snows are deepest is where they have their highest populations. That is where the wild turkey seems to survive the best, and this, interestingly enough, is true in Pennsylvania. Our highest turkey populations are those in those counties along the New York border in the birch/beech/maple forests where snows are deepest, temperatures are lowest and where you would expect the food to be the least. We have found that winter starvation or winter kill is not the important factor, but actually that it is hunting pressure. Our northern tier counties have the least pressure simply because we have more wild area, and it is harder to get into; whereas the southern mountains are very accessible, having parallel roads on both sides of them. We have had seasonal harvests up to 70 per cent in that area, which obviously is too high.

MR. LAMB [New Mexico]: If I heard right, you made the statement in your paper that predation was inconsequential. I am ready to go along with that, but we are having a hard time explaining that. Would you care to discuss that any further and mention what predators might have been present?

DR. LATHAM: I think one of the most interesting points to bring up in that connection is the fact that when our wild turkey was expanding its range from approximately 3 million to the present 13 to 14 million acres and growing from an annual kill of 2,000 approximately, to an annual kill of 20,000, we had the highest fox population in history. We also had normal numbers of great horned owls and hawks and some bobcats and a few other things, but apparently, at least, our adult predation is almost zero except for newly stocked game farm birds, and I am talking about wild hatched turkeys. Once they reach the adult stage, they appear to be almost secure. We have followed flocks through the winter many times in our study areas and have found them to come out exactly the same number in the spring as they started in the fall, or perhaps with the loss of one bird out of 16 or 18. It isn't anything to worry about in our state, but some poults, obviously, are bound to be taken by predators. We consider the fox and the horned owl the most important of all of our predators, and even those don't take many.

MOOSE HARVESTS IN NEWFOUNDLAND AND FENNOSCANDIAN COUNTRIES[1]

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Many of the people of Newfoundland live close to the land and obtain a large part of their protein requirement from the harvesting of wild animals. The greatest importance of the moose *(Alces alces)* is related to the meat that it provides these people, not to the recreation that hunting affords them. The objective of my research program in the province was to obtain a comprehensive understanding of the ecology and population dynamics of the moose population so that it can be intensively harvested on a long-term basis.

The purpose of this paper is to give details of the phase of the program that dealt with the moose harvest. Newfoundland's moose-hunting regulations, zoning system, kills and sex ratios will be discussed. Comparative information and data will also be discussed for Norway, Sweden and Finland. Fennoscandian hunting regulations and methods will be presented in review form, since little information has been published in English.

I wish to acknowledge the assistance of, and to express my gratitude to, many people who contributed to this part of the research program, including approximately 1,500 people who either reported their observations of moose on record cards or collected and submitted mandibles and reproductive tracts from the animals they killed. Arthur Butt, Stephen J. Hall, Ephraim Balsom, George Hicks, Jr., and R. J. Callahan, all members of the field staff of the Newfoundland Department of Mines and Resources, were especially active in the mandible-collection program. Four of Arthur Butt's sons cleaned almost half of the 2,017 mandibles in the collection. Stephen J. Hall and D. W. Simkin assisted me in the age classification of mandibles, work that required patience and exactitude. In 1958, A. T. Bergerud of the Department of Mines and Resources, made a special helicopter survey in the southwestern interior part of Newfoundland to obtain additional data on moose sex ratios. Marianne von Ah assisted me with the translation of articles from *Svensk Jakt*. B. Haglund of Sweden, K. Rom of Norway and T. U. Mäki of Finland criticized the sections which deal with hunting regulations and hunting methods in their countries. My wife, Dorothy, compiled the sex-ratio data.

The study was conducted while I was employed by the Newfound-

[1]A contribution of the Newfoundland Department of Mines and Resources and the Department of Forestry and Wildlife Management, University of Wisconsin.

land Department of Mines and Resources. Program planning and report preparation were done at the University of Wisconsin under the direction of Joseph J. Hickey and Robert A. McCabe. I am also grateful for the financial support of the Wildlife Management Institute during a year and a half when I was doing laboratory work and preparing this report.

SOURCES OF INFORMATION

The Newfoundland kill data were compiled from big-game license returns by personnel of the Wildlife Division of the Department of Mines and Resources. Returns are received each year from approximately 90 per cent of the license holders. These returns, made on a separate portion of the license, indicate where the hunting was done, what was killed (male or female moose or caribou *(Rangifer caribou)*), date of kill, the length of time hunted, and the number of moose and/or caribou, by sex, that were observed during the hunt.

During the 1953-56 hunting seasons, mandibles (lower jaws) and reproductive tracts were obtained from hunters' kills. The collections were island-wide in 1953 and 1956, and from part of the Central District in 1954 and 1955. In total, 2,017 mandibles and 561 reproductive tracts were collected (Pimlott, 1959).

Sex ratios were obtained from the reported kill, the fetus and mandible collections, moose-record cards, and field-party studies. The last two sources of information have been discussed previously (Pimlott, 1953).

The principal sources of my information on Fennoscandian moose have been *Älgen* (Schuncke, 1949), *Elgen i Norge* (Olstad, 1934), *Till älgjägare* (Liljefors and Liljefors, 1952), as well as papers and kill data from *Svensk Jakt,* the Journal of the Swedish Hunters' Society.

HUNTING REGULATIONS

Newfoundland

Moose hunting in Newfoundland began in 1935 with a bull-only regulation and with a limited license sale of 80, only 33 of which were issued. The limited sale was continued until 1944, when a 300-limit was reached, of which 296 were issued. From 1945 to 1951, license sale was unrestricted, and bull-only hunting was permitted over much of the island during the 3-month period of September, and November through December. (By tradition, the hunting season was closed in October.) In 1952 the first zoning system was introduced and the season shortened to 1 month in accessible areas, and to approximately 2 months in inaccessible areas (Pimlott, 1953).

The zoning system is still in use but has been gradually modified.

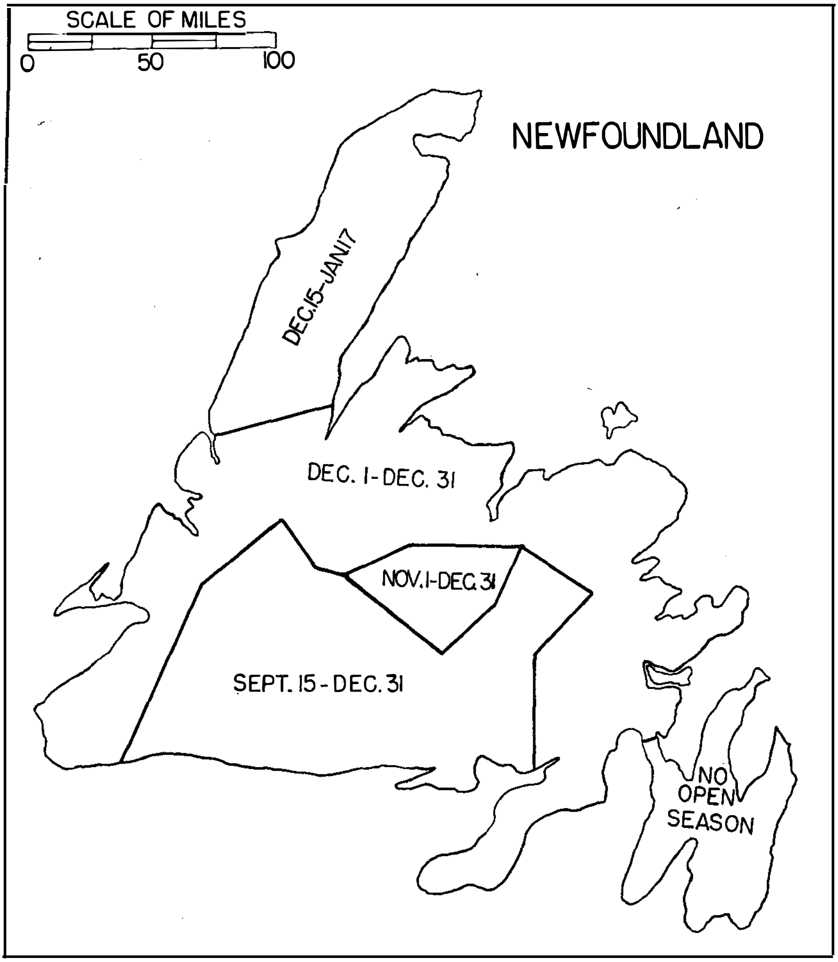

Figure 1. Hunting areas and seasons, 1958.

The zoning map for 1958 is shown in Figure 1. The objectives of the zoning system were: (1) to divert all early-season hunting into interior areas and thereby to increase moose hunting in underharvested regions; (2) to establish hunting seasons in accessible and relatively accessible areas, favoring local "meat hunters" who, generally, have only a short time to hunt and must depend on natural refrigeration for the preservation of meat.

The first island-wide any-moose season was held in 1953. It was followed in 1954 by a bull-only regulation in all parts of the hunting range except for the Sandy-Millertown Area of central Newfoundland where especially high moose densities existed. In 1955, island-wide either-sex seasons were again established and are still in force.

From 1945 to 1952, resident license fees were $25 during the early season and $5 during the late season. A resident could purchase a license for either of the seasons but not for both. In 1953 the late-season license fee was increased to $10. In 1956 the 2-license system was abolished; residents can now hunt any time in the season on the same license. The change in the resident licensing system was an attempt to increase resident hunting pressure in the interior zone.

Nonresident license fees were $25 until 1955, when they were increased to $35. A special big-game license costing $75 was introduced in 1953; it permitted the holder to take one moose and one caribou instead of one of either species. One of the objectives of issuing this license was to encourage the kill of more moose in the interior zone. This special license was relatively unpopular and was discontinued in 1955.

In 1958, in the face of a declining caribou population, separate moose and caribou licenses were sold for the first time.

Sweden

The following review of past moose-hunting regulations is summarized from Skuncke (1949: 17-20, 303-306). The discussion of current hunting regulations, the seasons, the licensing system, and the hunting methods, is based principally on material that has appeared in *Svensk Jakt*. This material included editorials, hunting-season announcements, anonymously authored reports of the proceedings of the Congress of the Swedish Hunters' Society, and articles by Höjer (1953a, 1953b, 1954), Haglund (1954, 1956), Hamilton (1953), and Nordell (1954, 1955). In the discussion I am interpreting or combining facts from many sources and will not attempt to document individual statements.

From 1593 to 1789, big-game hunting in Sweden was restricted to nobility. In 1789, commoners who owned taxable land were given the privilege of hunting on it. During the next 35 years, moose were heavily hunted and were almost extirpated by 1825. The population recovered during a 10-year closed season that followed, but was again heavily exploited after the closed season ended. The Swedish Hunters' Society, formed in 1830, exerted influence on big-game regulations, and hunting seasons were progressively shortened. In 1853 the hunting season ran from August through October; by 1912 it was reduced to only 6 days. There have been no completely closed seasons since 1835 although wide use of partially closed seasons has been made at different times, especially during the period between 1921 and 1926 when the greater part of the country had no open season. Peterson's statement (1955:211) that a completely closed season was enforced from 1920 to 1928 is erroneous. Skuncke (1949: 322) gives kill data covering this period.

One of the most significant advances in Swedish moose management was made in 1931 when legislation was introduced permitting hunting by special license. Persons, or groups of persons, who owned, or held hunting rights on, large blocks of land, were allowed to apply for a permit to kill a predetermined number of moose during a special 2-week season. In 1938, a revision permitted an extension of the season to 1 month. This became the standard special-season for the whole country.

The two types of season are still in force. The general season usually begins on the second Monday of September in northern Sweden, and on the second Monday in October in southern Sweden. The general season is usually 3 to 5 days long; however it has been as long as 13 days in parts of southern Sweden. Any person may hunt, but the law requires that the hunter have either the private landowner's or a government permit, depending on whether the hunting is on private or crown land. The special-license season begins at the same time as the general season. The size of the allowable kill in a special-season area depends on the number of moose in the area, and on the extent of damage to forest reproduction and to crops. In determining allowable kill, Swedish game authorities consider that an unharvested population will increase at a rate of approximately 30 per cent of the winter population. Kill limits on special-season areas are set by the county government, which is advised by local wildlife and moose-damage committees, and by a hunting consultant. There is no restriction on the number of persons who may hunt in a special-season area, only on the number of animals killed.

There is now a movement to eliminate the general season and to conduct all hunting under special-type regulations. The difficulties of undertaking precise management of the kill under the 2-season system, has stimulated this action.

Between 1900 and 1958, a country-wide closed season on cow moose was reported only in 1904. Schuncke (1949:308) states, "In the author's opinion, the practice of a closed season on cows is most nearly analogous to the handing of firearms to a blind man. This practice has little in common with true moose conservation."

Closed hunting seasons on calves have been widely used. A completely closed season was established in 1912. Calf hunting during the general season was legalized in some counties in 1953. It is now being encouraged in a number of counties, to keep the moose population in check and to reduce hunting pressure on adult age-groups. Skuncke (1954) stated that under ideal conditions, calves should comprise 25 per cent of the total kill.

Since 1951, each hunter has been required to have a license for each county in which he hunts. This replaced a previous system in which the hunter could purcase either a country, county, or parish license. The county license is approximately $2. In addition to the cost of the general license, there is a fee of from $5 to $20 for each moose killed. This fee varies from county to county, is different for the general and special seasons, and is up to twice as much for adult moose as for calves.

Norway

This discussion of Norwegian hunting regulations is based on papers by Olstad (1934) and Rom (1956).

In 1863, moose-hunting privileges were extended to landowners who were given the privilege of killing one moose on their own land. The size of the holding was not considered. This law remained in force for 68 years. Control of the kill was exercised by closing or by varying the length of the hunting seasons. The most extensive period of closed seasons was in the 1920's. However, hunting was never stopped over the entire country.

There has been no widespread use of bull-only regulations. In 1932, a fixed hunting season of 5 days and a closed season on calves were established; the latter is still in force. In 1951, a new law was enacted which completely changed the basis for moose hunting. Hunting privileges of individual landowners no longer have blanket application. Hunting permits are issued for specific areas, the size of which may vary from year to year depending on moose density, range conditions, and moose damage to forest and crops. Owners, or holders of the hunting rights, of small blocks may unite to form areas large enough to meet the minimum-size requirement. A special license has also been established for moose hunting. The fees are now approximately $10 for each moose killed and $2 for each person participating in the hunt.

Finland

This account is based on a paper by T. V. Mäki (1955) that appeared in *Svensk Jakt*. No historical information was included.

There is no general moose-hunting season in Finland. All hunting is by area licenses. Applications for these are submitted through local wildlife committees, which append their recommendations and pass them on, either to the county board (for hunting on private land) or to the Forestry Department (for hunting on state land). The license specifies the number of moose that can be killed in the area. It is illegal to shoot a cow moose which is followed by a calf.

The hunting season is from October 16 to November 30, and the fee is approximately $25 for each adult moose and $12.50 for each calf killed. A recently introduced regulation requires that all moose hunters take a shooting test. Tests are conducted at shooting ranges, on motionless and on moving targets. Mäki states that all moose hunters are encouraged to qualify for a "moose badge." The requirement for this is to make six 100-yard shots (all killing) in 1 minute at a motionless target, and four shots at a moving target, only one of which can be a miss.

Neither Norway nor Sweden has yet brought such a hunter-ability test into its licensing. However, under the new Norwegian law, such regulations can be made (Rom, 1956). In Sweden moving-target ranges are now in wide use, and a shooting test is proposed as part of the new hunting regulations.

FENNOSCANDIAN HUNTING METHODS

Moose-hunting methods in the Fennoscandian countries are much more varied than they are in North America. Several Swedish publications are available which give detailed information on hunting techniques, viz., *Älgen* (The moose, Skuncke, 1949); *Jakten jägarens handbok* (Hunting, the hunters' handbook, edited by Haglund and Notini, 1951); and *Till älgjägare* (To the moose hunter, Liljefors and Liljefors, 1952). Bosaeus (1952) gives an interesting account, in English, of the use of dogs. Rom (1956) and Mäki (1955) give brief descriptions of hunting in Norway and Finland, respectively.

Dogs are used for moose hunting in all three countries. The two principal methods are "loshund" and "ledhund." In the first instance, the dog is loose and quarters the ground around, but at a considerable distance from, the hunter. During the search contact is maintained between the dog and the hunter. When the dog locates a moose and brings it to bay, it then begins to bark. If the moose gets away, the dog becomes silent until the moose is again brought to bay. In the case of "ledhund" hunting, the dog is leashed and leads the hunter to the moose but does not bark at any time. The usual method is to work upwind with the dog picking up aerial scent, although it may also follow ground scent. Stalking plays an important part in the final stage of this type of hunt. Dogs may also be used as part of a line of drivers in drive hunts, or in combination with pass hunting, in which a hunter remains on watch at a moose pass. Still hunting is also used in the three countries.

In all three countries, there is strong feeling in favor of the use of dogs in moose hunting. Bosaeus (1952) paraphrases the sentiment,

TABLE 1. NEWFOUNDLAND MOOSE KILL, 1945-57

	Big Game[1]		Moose		
Year	Licenses Issued	Per Cent Returns	Reported Kill	Adjusted Kill[2]	Hunting Success[3]
1945	2,475	99	747	753	30
1946	3,845	90+	1,213	......	32+
1947	5,048	90+	1,476	......	29+
1948	6,021	87	2,081	2,239	37
1949	5,931	75	1,937	2,264	38
1950[4]	7,240	94	2,650	2,736	38
1951[4]	8,660	92	3,332	3,481	40
1952[5]	6,523	92	2,615	2,723	42
1953[6]	5,196	95	2,682	2,757	53
1954	5,754	90	2,371	2,497	43
1955	6,624	94	3,671	3,795	57
1956	8,654	89	4,439	4,692	54
1957	8,797	87	4,577	4,910	56

[1]During this period a big-game license permitted the hunter to kill a moose or a caribou.
[2]In this adjustment of kill data for the province, nonreporters are considered to be half as successful as reporters (Pimlott, 1953).
[3]Based on the number of licenses issued and the adjusted kill data. As a small percentage of big-game license holders were successful caribou hunters, the percentages of successful moose hunters shown here are slightly affected by the opportunities to shoot a caribou instead of a moose.
[4]Totals for these years differ slightly from those previously reported (Pimlott, 1953), and were rechecked for me by Shirley Earle.
[5]Zoning system introduced and length of hunting season shortened.
[6]First any-moose season; license fee increased from $5.00 to $10.00.

"All moose hunting in Sweden is not done with dogs—but it should be."

KILLS AND EXPLOITATION RATES

Approximately 36,000 moose were legally killed in Newfoundland from 1935 to 1957. I consider that at least 60,000 have been harvested, legally and illegally, since the introduction of six moose, two in 1878 and four in 1904 (Pimlott, 1953).

Annual Kills

During 1945 to 1951, the annual kill increased from 753 to 3,481 moose. The shortened season of 1952, the doubling of the license fee in 1953, and a bull-only regulation over much of the island in 1954, combined to reduce the legal kill to approximately 2,500 annually for the 3 years. With the return to an any-moose season in 1955, the kill increased to 3,800. In 1956, a 30-per-cent increase in license sale resulted in a proportional increase in the kill, which reached 4,692 animals. The license sale increased only slightly during 1957, when the annual legal kill was just under 5,000 animals (Table 1).

Moose-kill records for Sweden and Norway extend back approximately 70 years. Skuncke (1949:322, 323) gives the Swedish kill records from 1881 to 1948. The January or February issue of *Svensk Jakt* usually contains the kill data for the previous hunting season. Since 1953, the data have been broken down by counties, by general and special seasons and by sexes, and a separate calf-kill record has been given. Olstad (1934) gives a detailed analysis of the Norwegian kill from 1889 to 1930. Rom (1956) gives the total annual kills from 1935 to 1954 and provided me *(in litt.)* with similar data that extend the kill records up to 1956. Mäki (1955) gives records of the Finnish moose kill for recent years.

From 1881 to 1919, the annual kill in Sweden was usually between 1,500 and 3,000 animals. The extensive closed seasons of 1920 to 1924 reduced the average kill for the period to 803, with a low in 1923 of 381 animals. The last partially closed season ended in 1926, and the average kill for the 1925 to 1929 period was 2,902. The 5-year kill averages show a constant increase since that time. The average annual kill for the 1930's was 6,776; for the 1940's, 12,263; and for the 1950's, 23,724.

Wennmark (1958) divided Sweden into four main areas, based on kill trends from 1940 to 1957. In Area 1 (northern and central counties comprising 68 per cent of the country's moose range), the kill increased several hundred per cent. In Area 2 (12 per cent of the range), the kill has shown a downward trend after a peak in the early 1950's, and in 1957 it was quite close to the 1940 level. In Area 3 (17 per cent of the range), the kill declined in the mid-1940's, but by 1957 it had increased to a slightly higher level. In Area 4 (3 per cent of the range), the 1957 kill was at the 1940 level and showed only minor irregular fluctuations during the 17-year period. In summary, virtually all the increase in the Swedish moose kill since 1940 has occurred on the northern two-thirds of the range, where at the beginning of the period, density was at a relatively low level. The 1947 and 1957 kill data for Wennmark's four areas are given in Table 2.

From 1889 to 1919, the Norwegian kill varied between 650 and 1,425 animals annually. In the 31 years, there were 11 kills below, and 21 kills above, 1,000 animals. The extensive closed seasons of the early 1920's reduced the kill to 200 animals in 1920, and down to 50 in 1921. After the restrictions were eased, the kill increased again and remained between 1,100 and 1,200 during 1925 to 1930. From 1935 to 1944, 9 out of 10 kills lay between 1,185 and 1,669 animals. During the invasion year of 1940, only 210 moose were reported killed. In 1945, the kill increased 60 per cent, to 3,246 animals, presumably as the result of extended seasons, and in 1956 it was 5,400 animals.

The moose population in Finland was decimated during the war years, and the kill was restricted for several years thereafter. The kill of 468 animals in 1949 had increased to 2,672 animals by 1954.

TABLE 2. MOOSE KILL IN SWEDEN, 1947 AND 1957[1]

Area and County	Square Miles[3]	Kill 1947	Kill 1957	Per Cent Change[4]	Moose Killed Per 100 Sq. Mi. (1957)
Area 1					
Värmland	6,379	729	2,399	229	38
Kopparberg	9,598	1,345	3,824	184	40
Gävleborg	6,421	846	2,600	207	40
Västernorrland	8,813	397	1,988	401	23
Jämtland	12,124	921	4,429	381	37
Västerbotten	15,300	272	1,759	547	11
Norrbotten	20,272	77	959	1,145	6
Entire area	78,907	4,587	17,958	291	23
Area 2					
Stockholm	2,467	793	857	8	35
Uppsala	1,639	805	695	−14	42
Södermanland	2,019	754	1,016	35	50
Ostergötland	3,244	894	801	−10	25
Orebro	2,885	897	1,129	26	39
Västmanland	2,162	890	1,099	23	51
Entire area	14,416	5,033	5,597	11	39
Area 3					
Jönköping	3,746	361	604	67	16
Kronoberg	3,108	449	658	47	21
Kalmar	3,464	687	685	0	20
Halland	1,368	180	395	119	29
Göteb o. Bohus	1,419	175	306	75	22
Alvsborg	3,997	512	1,027	101	26
Skaraborg	2,473	443	744	68	30
Entire area	19,575	2,807	4,419	57	23
Area 4					
Blekinge	1,007	73	127	74	13
Kristianstad	1,799	187	212	13	12
Malmöhus	619	59	32	−46	5
Entire area	3,425	319	371	16	11
Country total	116,323	12,746	28,345	122	24

[1]Kills from *Svensk Jakt* (1947, #12; 1958, #2).
[2]Wenmark (1958) divided the country into these four areas on the basis of a comparison of the kills from 1940 to 1957. The 1957 kills in Areas 2, 3 and 4 are close to the 1940 level.
[3]From Peterson (1955); computed from Lubeck (1947).
[4]All values are positive except where a negative sign is used.

Exploitation Rates

Area Yields.—Almost 90 per cent of the Newfoundland kill is occurring in 55 per cent (21,000 square miles) of the area that is open to hunting. This area contains most of the island's good moose range (Pimlott, 1953). To avoid dealing with small units where egress and ingress could influence the data, I have divided the high-kill range into six units varying in size from 2,500 to 5,000 square miles, and the low-kill range into three units varying in size from 4,500 to 6,500 square miles (Table 3, Fig. 2). The land area of the units has not been reduced to exclude nonforested land, or water areas, as has been done for Norway (Olstad, 1934) and Sweden (Lubeck, 1947).

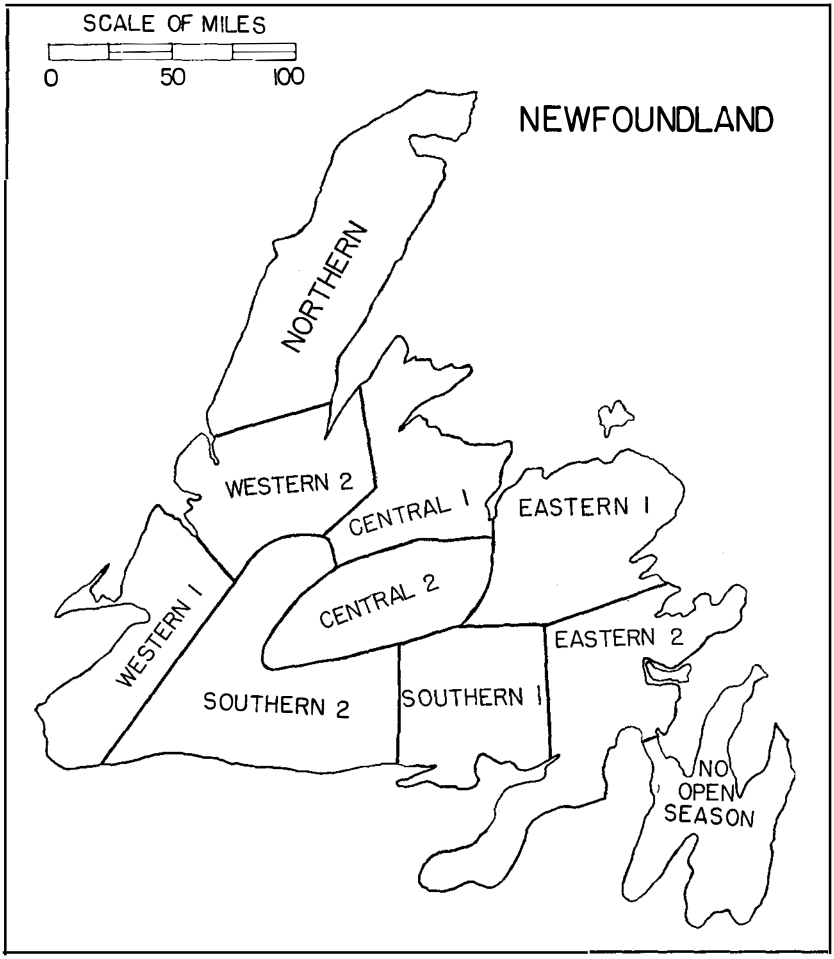

Figure 2. Moose-kill districts.

The kill intensity in the high-kill areas varied from approximately one moose per 3 square miles to one moose per 9 square miles. The average kill for the 21,000 square miles was approximately one moose per 5 square miles.

In the interior and south coast areas, to which I refer in this paper as the "Southern District," the kill varied from approximately one moose per 14 square miles to one per 23 square miles. This low kill is a product of two factors—limited accessibility and poor range.

TABLE 3. NEWFOUNDLAND MOOSE KILL, 1957

District	Approximate Area	Total Kill	Moose Killed Per 100 Sq. Miles	Per Cent of Total Kill
Western 1	2,500	595	24	12
Western 2	3,000	640	21	13
Central 1	3,500	368	11	8
Central 2	3,000	651	22	13
Eastern 1	4,000	1,285	32	26
Eastern 2	5,000	735	15	15
Subtotal	21,000	4,274	20	87
Southern 1	4,500	316	7	6
Southern 2	6,500	283	4	6
Northern	6,000	37	0.6	1
Subtotal	17,000	636	4	13
Grand total	38,000	4,910	13	100

There is only one logging road in the eastern part of the Southern District. A high proportion of the range is marginal, or submarginal, for moose in winter (Pimlott, 1953).

In the Northern District, only 37 moose were reported killed in 6,000 square miles, or 1 moose for 162 square miles. The moose population is low over much of the district, and many woodsmen there state that they have never seen a moose. However, I believe that the illegal kill is much larger than the legal kill in this district, therefore, the figures cited here for this part of the island are probably misleading.

The 1957 moose kill in Sweden varied from 1 moose killed per 2 square miles in Södermanland and Västmanland, to 1 per 21 square miles in Norrbotten. The country-wide average was approximately 1 moose killed for each 4 square miles of moose range (Table 2). In Norway, the 1956 average was approximately 1 moose killed for each 6 square miles of moose range.

Annual Yields.—Since I was unable to obtain exact data on moose-population densities in Newfoundland, I cannot report objectively on the annual yield. I believe that 15 to 25 per cent of the population is being harvested in the high-kill section of the province.

Sweden made winter inventories of its moose population in 1945 and 1953 (Hamilton, 1953). The inventories were conducted on large-sample units, *i.e.*, private forests, crown lands, game preserves, and pulp-company holdings. The field work was done by volunteers who were organized in advance. Large numbers of people participated in the projects. In 1953, for example, 2,186 men worked in January surveys of Jämtland and Västerbotten counties. Over 30 per cent of the country's moose range was included in the areas sampled. The moose population for the country was estimated at approximately 47,000 in 1945, and at 90,000 in 1953. The highest

TABLE 4. MOOSE POPULATIONS AND ANNUAL YIELDS IN SWEDEN[1]

Area[2] and County	Estimated Population 1953	Per Cent Population Change 1945-53	Winter Moose Density Per Sq. Mile	No. Killed 1952	Per Cent of 1952 Population Harvested
Area 1					
Värmland	7,700	255	1.2	1,600	17
Kopparberg	7,200	71	0.8	2,012	22
Gävleborg	7,568	121	1.2	1,598	17
Västernorrland	7,500	87	0.9	1,479	16
Jämtland	10,600	140	0.9	3,007	22
Västerbotten	6,500	171	0.4	1,137	15
Norrbotten	6,905	130	0.3	411	6
Entire Area	53,973		0.7	11,244	17
Area 2					
Stockholm	(1,400)[3]	....	(0.6)[3]	1,119	?
Uppsala	3,500	46	2.1	1,161	25
Södermanland	4,000	167	2.0	1,243	24
Ostergötland	3,750	34	1.2	1,285	26
Orebro	4,080	54	1.4	1,469	26
Västmanland	(3,200)[3]	....	(1.5)[3]	1,150	?
Entire area	15,330[4]		1.6[4]	5,158[4]	25
Area 3					
Jönköping	1,700	162	0.5	556	25
Kronoberg	1,900	32	0.6	621	25
Kalmar	3,835	119	1.1	860	18
Halland	1,700	295	1.2	448	21
Göteb o. Bohus	720	71	0.5	216	23
Alvsborg	2,460	34	0.6	920	27
Skaraborg	1,500	—60	0.6	806	35
Entire area	13,815		0.7	4,427	24
Area 4					
Blekinge	209	82	0.2	99	32
Kristianstad }				181	
Malmöhus }	300	—33	0.1	45	43
Entire area	509		0.1	325	39

[1]Based on winter census data from 1945 and 1953 and on the 1952 kill data (Hamilton, 1953).
[2]See Table 2.
[3]Not censused in 1953; figures in parentheses are from 1945 inventory.
[4]Does not include Stockholm and Västmanland which were not included in the 1953 census.

county moose density was 1.5 moose per square mile in 1945, and 2.1 per square mile in 1953. These densities are much lower than the 5 moose per square mile which Peterson (1955:205) suggested must have been present in some Swedish counties in 1941 and 1948.

To obtain data on annual yields for Sweden, I combined the 1952 kill and the 1953 population estimate to obtain an estimate of the prehunting-season population. In 1952, the estimated yield for the four areas previously discussed was 17, 25, 24, and 39 per cent, respectively (Table 4). Wennmark (1958) gives further information for Örebro county, which was censused again in 1957. Comparison of the county population and kill indicates that annual yields of 28, 25,

TABLE 5. AGE CLASS DISTRIBUTION IN THE MOOSE KILL OF NEWFOUNDLAND[1] AND SWEDEN

Area	Per Cent in Each Age Class[2] Calf	I	II	III	IV+	Total Collection	Reference
Newfoundland							This study
Western	17	23	21	19	20	352	
Central	11	24	21	17	27	994	
Eastern	20	29	18	15	18	583	
Southern	14	25	20	23	18	88	
Total	15	25	20	17	23	2,017	
Calves excluded	....	30	23	20	27	1,721	
Sweden (both sexes)[3]	....	23	16	14	47	1,824[4]	Skuncke (1949:339)
Sweden (bulls only)[5]	....	48	17	16	19	341	Liljefors and Liljefors (1952:14)

[1]Includes material from 1953 and 1956 in Western, Eastern and Southern Districts and from 1953 to 1956 in the Central District.
[2]Newfoundland age classes are based on tooth erosion (Passmore, Peterson and Cringan, 1955). Sweden age classes are based on tooth-erosion method described by Skuncke (1949).
[3]From several counties in central Sweden.
[4]Eight calves are not included in the total or in the calculation of age class percentages.
[5]From Uppsala County only. The high frequency of yearlings was not discussed by the original authors.

and 26 per cent were obtained in the 1954, '55 and '56 hunts, respectively. These compare favorably with the highest yields which are being obtained from deer populations in the United States (Anonymous, 1955).

Rom (1956) and Mäki (1955) give population and kill figures for Norway and Finland, respectively, which suggest annual yields of 20 to 30 per cent. However, I do not have any information on the basis for their population estimates.

In summary, the 1957 kill data for Newfoundland, Sweden and Norway show that the number of moose killed per unit area is similar. Newfoundland has an average kill, on accessible range, of 1 moose per 5 square miles. The averages for Sweden and Norway are 1 moose per 4 square miles and 1 moose per 6 square miles, respectively. Sweden is obtaining annual yields of 25 per cent of the fall moose population, over large areas. Similar annual yields are indicated for Newfoundland, Norway and Finland; however, they are not supported by quantitative data, as are those from Sweden.

Other Features of the Kill

Age-class Distribution in the Kill.—Between 1953 and 1956, I obtained 2,017 mandibles from hunter kills. Calves were aged by dentition, yearlings by tooth replacement and staining, and older animals by a tooth-erosion method developed by Passmore, Peterson and Cringan (1955). On the basis of results from another study (Sergeant and Pimlott, 1959), I believe that the erosion method underestimates the ages of animals, and that the error is quite large for animals in Class IV and older age-classes. For this reason, I have grouped the data for these classes (Table 5).

In Sweden, there are two records of comparable mandible collections: Skuncke (1949:339) reported on a collection of 1,832, and Liljefors and Liljefors (1952:14) gave the percentage occurrence of year-classes in a collection of 341 mandibles (Table 5). The Swedish aging methods (Skuncke, 1949) give exact year-classes.

Fifteen and 25 per cent of the animals in the Newfoundland collection were calves and yearlings, respectively. When calves are excluded from the Newfoundland data, yearlings comprise 30 per cent of the yearling and adult kill; in this segment of the kill 23 per cent of the animals were in Class IV or older age-classes. In Skuncke's (1949:339) collection, 23 per cent of the animals were yearlings, and 47 per cent were 4 years of age or older. In the Liljefors' (1952: 14) collection, yearlings comprised 49 per cent of the total, and animals 4 years of age or older, 19 per cent.

Newfoundland yearlings comprised a significantly higher percentage of the study collection in the first year (1953) than in subsequent years. I believe that this was the result of a higher calf mortality after the introduction of an any-moose season. Yearlings are more vulnerable to hunting than are adult moose, and so comprise a higher percentage of the kill than of the population (Pimlott, 1959). The high occurrence of yearlings reported by Liljefors and Liljefors (1952:14) suggests that their kill data may contain a similar bias.

Hunting-season Kill Distribution.—In the 1956 Newfoundland hunt, approximately 25 per cent of the moose were killed during September, October, and November, and 75 per cent during December. The kill distribution during the 4 full weeks and 1 partial week of December, was 26, 15, 24, 24, and 11 per cent, respectively. The marked drop during the second week of the season was characteristic of all parts of the island, although I do not understand why it occurs.

Hunter Success.—Newfoundland moose-hunter success increased from 30 per cent in 1945 to 56 per cent in 1957 (Table 1). These values are lower than the actual percentages, since approximately 5 to 10 per cent of the hunters bought licenses but did not hunt, and since 3 to 10 per cent of the total kill is comprised of caribou. The changes from the bull-only to any-sex regulations had a direct effect on hunter success. In the 1952 season, 42 per cent of the hunters were successful. The success increased to 53 per cent in the 1953 any-moose season and decreased again to 43 per cent with the return to the bull-only regulation in 1954.

In the three high-kill districts, hunter success was highest in the Rattling Brook–Millertown Area (Central 2, Fig. 2), in both 1956 and 1957. In these years, 80 and 77 per cent, respectively, of all persons hunting in the area killed moose. Hunters were least suc-

TABLE 6. NEWFOUNDLAND MOOSE HUNTER SUCCESS AND TIME REQUIRED TO MAKE A KILL

	Hunter Success[1]				Hunting Time—1956[2]			
	1956		1957		Per Cent of Hunters Who Made a Kill in			
District	Per Cent Successful	(Sample Size)	Per Cent Successful	(Sample Size)	1 Day	2 Days	5 Days	(Sample Size)
Western 1	54	(1,083)	67	(828)				
Western 2	64	(895)	67	(886)				
Subtotal	58	(1,978)	67	(1,714)	33	71	88	(895)
Central 1	60	(513)	67	(512)	32	70	83	(288)
Central 2	80	(901)	77	(789)	41	82	93	(556)
Subtotal	73	(1,414)	73	(1,301)	38	78	90	(844)
Eastern 1	65	(1,464)	66	(1,799)				
Eastern 2	47	(1,189)	55	(1,248)				
Subtotal	57	(2,653)	62	(3,047)	29	65	82	(1,485)
Southern 1	85	(383)	80	(368)	37	77	91	(208)
Southern 2	73	(244)	81	(325)	43	85	90	(21)
Subtotal	81	(627)	81	(693)	37	78	91	(229)
Island Total[3]	63	6,672	67	6,755	33	70	86	3,453

[1]Based on the hunters who stated the area in which they hunted; southern hunter success is not directly comparable to the other districts because of higher percentage of hunters making kills in September and October when hunting is easier, and because of marked differences in the habitat.

[2]Hunting times calculated for kills made in November and December. All data could not be broken into subdistricts because of the way it was originally tallied.

[3]Does not include the Northern District.

cessful in the southern part of the Eastern District, where 47 and 55 per cent were successful in 1956 and 1957 (Table 6). The variation in hunter success in the three districts appears to have a direct correlation with moose densities.

The highest hunter-success rates were attained in the Southern District; however, these rates also reflect early-season hunting and wide difference in habitat conditions; hence, they cannot be meaningfully compared with those from the other districts.

The time required to kill a moose also apears to have merit as an index of density. Hunting periods calculated for November and December showed that approximately 86 per cent of all successful hunters killed a moose within 5 days. Similar percentages for Western, Central and Eastern districts were 88, 90 and 82 per cent, respectively (Table 6).

SEX RATIOS

The sex ratios of moose killed in Newfoundland, Sweden and Norway are very similar. In Newfoundland, the sexes of approximately 15,000 moose killed in 1953 and 1955-57 were reported by hunters. In each of the 4 years and in each of the four major districts, males comprised more than 55 per cent of the kill. The ratio for the 4 years was 59 ♂♂ : 41 ♀♀ (Table 7).

In Sweden between 1906 and 1957, bulls comprised 54 per cent of

TABLE 7. SEX RATIOS OF NEWFOUNDLAND MOOSE

District	Kill[1]		Field Observations[2]	
	Per Cent Males[3]	(Sample Size)	Per Cent Males[3]	(Sample Size)
Western	60	(4,005)	55	(1,277)
Central	56	(3,877)	51	(2,553)
Eastern	58	(5,717)	53	(1,459)
W-C-E- total	58	(13,599)	52	(5,289)
Southern[4]	72	(1,387)	60	(892)
Island total	59	(14,986)	54	(6,181)

[1]Includes data from all age classes for 1953 and 1955-57, the years when any-sex seasons were held over the entire island.

[2]All animals were classified as adults, however a considerable number of yearlings are probably included. The data are for the 1950-55 period.

[3]The 0.05 confidence limits are ±3.3 per cent for samples of 900; ±2.5 per cent for samples of 1,500; ±2.0 per cent for samples of 2,500; ±1.4 for 5,000; and ±1.0 for 10,000.

[4]More than 50 per cent of the animals were killed in September and October seasons; considerable trophy hunting in the district.

a kill of approximately 382,000. I computed the county-kill sex ratios for 1950 to 1957 (Table 8) from the annual-kill data in *Svensk Jakt.* Only one county, Uppsala, had a 50:50 ratio; in all others more than 50 per cent of the animals killed were bulls. In 17 of 23 counties the ratios departed significantly from 50:50.

In Norway, of approximately 42,000 moose killed between 1889 and 1930, 54 per cent were males (Olstad, 1934). The county breakdown shows that the trend is consistent for most of the country. For only one county, Vestfold, did the ratio fall to 50:50; in 7 of 12 counties it differed significantly from this ratio (Table 9).

Since large samples can be obtained from kill returns, it is important to consider whether or not the kill sex ratios are representative of the sex ratios of the population. Skuncke (1954) considers that they are not. He states that, since 57 per cent of the kill are bulls and 43 per cent are cows, the surviving winter population must consist of 43 per cent bulls and 57 per cent cows. The North American big-game literature contains no record of population and kill sex ratios being the reverse of each other, in areas where both sexes are taken in the hunt.

Data on the sex ratios of Newfoundland moose were obtained from three additional sources—the fetal and mandible collections and field observations. All sources showed a preponderance of males. The sex ratio of 220 fetuses was 55:45 (Table 10). This suggests that more males are born than females, although the departure of this sample from 50:50 is not significant. In the mandible collection containing 1,912 animals of known sex, males comprised 56 per cent. The field data contain records for 6,181 adult moose that were observed between May and November of 1950-55 (Table 7). The sex

TABLE 8. KILL SEX RATIOS OF SWEDISH MOOSE, 1950-57[1]

County	Per Cent Males[2]	Sample Size
Stockholm	53	7,164
Uppsala	50	7,421
Södermanland	54	8,123
Ostergötland	52	7,463
Jönköping	54	4,193
Kronoberg	51	4,305
Kalmar	51	5,520
Blekinge	53 (± 4)	667
Kristianstad	54 (± 3)	1,287
Malmöhus	58 (± 7)	222
Halland	54 (± 2)	2,826
Göteb. and Bohus	55 (± 2)	2,007
Alvsborg	53	6,849
Skaraborg	54	5,535
Värmland	55	12,864
Orebro	54	9,180
Västmanland	54	8,340
South Sweden	53	93,966
Kopparberg	57	19,092
Gävleborg	56	14,411
Västernorrland	54	12,781
Jämtland	54	23,740
Västerbotten	53	10,260
Norrbotten	56	4,680
North Sweden	55	84,964
Entire country	54	178,930

[1]Computed from annual kill data given in *Svensk Jakt*.
[2]Confidence limits at the 0.05 level. Except where indicated all values are less than ± 2.

ratio varied from 51:49 in the Central District to 60:40 in the Southern. The ratios for the Western and Southern districts and for the island total departed significantly from 50:50. However, none of the observed ratios showed a preponderance of males comparable to the kill ratios.

I analyzed the Newfoundland and Swedish kill data for sources of bias. Hunter selection for sex is a possible source. Skuncke (1949: 324), Bosaeus (1952) and Rom (1956) mention that cows with calves are sometimes spared by hunters. In reading *Svensk Jakt,* one realizes how greatly moose antlers are prized by Swedish hunters. However, Skuncke (1949:324) states that in northern Sweden selection does not influence kill data, and there the kill has the highest percentage of males. This appears to rule out hunter selection as a major source of bias in Swedish data. However, I checked the 1953-57 kill for evidence of sex selection in the special season (when hunters have a longer period in which to hunt). The kill sex ratio in the general-season areas was 53.3:46.7 in a sample of 80,507 and 54.7:45.3 in a sample of 42,654 in special-season areas. The difference, although small, is significant, and suggests that sex selection may be a factor in the higher male percentage of the special-season areas.

TABLE 9. KILL SEX RATIOS OF NORWEGIAN MOOSE, 1889-1930[1]

County	Per Cent Males[2]	Sample Size[3]
Ostfold	54 (± 3)	1,156
Akershus	53 (± 2)	2,280
Hedmark	56 (± 1)	7,812
Opland	53 (± 2)	4,634
Buskerud	53 (± 2)	4,422
Vestfold	50 (± 2)	1,654
Telemark	53 (± 2)	3,453
Aust-Agder	53 (± 6)	260
Vest-Agder	59 (± 10)	99
Sør-Tröndelag	51 (± 2)	4,446
Nord-Tröndelag	54 (± 1)	11,668
Nordland	57 (± 4)	541
Entire country	54 (± 0.5)	42,425

[1]Computed from Olstad (1934).
[2]Confidence limits at the 0.05 level.
[3]Data for periods when closed seasons on cows were in force have been excluded.

The Newfoundland data are slightly influenced by a hunter-selection bias. In the four any-sex seasons in which nonresident hunters shot 357 moose, the kill sex ratio was 79:21. This differs significantly from the 60:40 ratio of animals taken by residents.

During the first 2 years, 1953 and 1955, of the any-sex season, resident hunters were required to purchase separate licenses for September-October and November-December hunting. The sex ratio of 85:15 in a sample of 411 for those years indicates that early-season residents were also inclined to select bulls. The data for September and October of 1956 and 1957, for Western, Central and Eastern districts, give a kill sex ratio not significantly different from the ratio for the remainder of the hunting season. The selection of males did not continue after the 2-license system was abolished and when more meat hunters began to hunt in the early part of the season. I conclude that the bias from these sources has not increased the over-all male ratio by more than 1 per cent, and has had the greatest effect on the Southern District ratios, where a considerable portion of the nonresident hunting, and of the early-season hunting in 1953 and 1955, occurred.

I am convinced that the deliberate selection of bulls does not influence the November-December kill data. Residents hunting at this time are primarily interested in obtaining meat, and the majority prefer cows to bulls. If the sex ratio of the population is even and a selection bias is operating, it would not influence the calf-kill sex ratio—nevertheless, the calf kill contains the highest percentage of males (Table 10).

Another possible source of bias is that bulls may be more vulnerable to hunting than cows. The long hunting seasons in Newfoundland permit a weekly computation of sex ratios. During the first 5 weeks of November and December, the kill sex ratios were 57:43,

TABLE 10. NEWFOUNDLAND AND SWEDISH MOOSE SEX RATIOS BASED ON FETAL AND MANDIBLE COLLECTIONS

Age-class	Newfoundland Per Cent Males[2]	Newfoundland (Sample Size)	Sweden Per Cent Males[2]	Sweden (Sample Size)
Fetus	55 (± 7)	(220)	....	....
Calf	60 (± 6)	(284)	....	(8)
Yearling	59 (± 5)	(484)	56 (± 5)	(424)
II	58 (± 5)	(381)	58 (± 6)	(293)
III	58 (± 6)	(325)	50 (± 6)	(272)
IV+	48 (± 5)	(438)	42 (± 4)	(835)
All ages	56 (± 2)	(1,912)[3]	49 (± 2)	(1,832)

[1]From Skuncke (1949:339).
[2]Confidence limits at the 0.05 level.
[3]Fetal data are not included in the total.

TABLE 11. SEX RATIOS[1] OF NEWFOUNDLAND MOOSE IN 1956 AND 1957 KILL

Week of the Season	Per Cent Males[2]	Sample Size
1	57 (± 3)	1,133
2	56 (± 4)	598
3	57 (± 3)	941
4	52 (± 3)	907
5	51 (± 5)	446
Five Weeks	55 (± 2)	4,025

[1]Based on the first 5 weeks of the season which in some areas opened in November and in others in December.
[2]Confidence limits at the 0.05 level.

56:44, 57:43, 52:48 and 51:49 (Table 11). The first three differ significantly from a 50:50 ratio, the last two do not. These data suggest that males are more vulnerable to hunting than females. The mandible collection offers additional evidence. Males predominate in the first four age-classes, the sex ratios of which show significant departures from 50:50 (Table 10). All older animals are grouped in one class, which has a sex ratio of 48:52. This differs significantly from each of the older classes (Table 10). Sckuncke's (1949:339) data show exactly the same pattern, but the trend from a predominance of males in young age-classes to females in older age-classes is even more pronounced.

These data from Newfoundland and Sweden indicate that a differential sex mortality is occurring. In heavily exploited moose populations, hunting is the main source of mortality. I believe that, at least for Newfoundland, the differential mortality is the result of males being more vulnerable to hunting than females, and that this is an important source of the bias that is influencing the sex ratio of animals in the kill.

Sight records of the two sexes were collected over much of the island and from a wide variety of habitats. Presumably this would tend to reduce the effect of differential habitat selection by bulls and cows, which occurs on western range (Cowan, 1950) and which is probably also influencing some of the Newfoundland data. My observations indicate that, in addition to selecting somewhat different summer habitat, cows are also more wary than bulls. However, these two factors are often difficult to separate.

The results of an intensive study on a limited area show how observational data can be influenced by these factors. During 1952-54 and in 1956, observations were made for varying periods and times between May and November at a study area in central Newfoundland. The greater part of the observations were made from hills which overlooked a burned-over area of approximately 3 square miles. The fires did not burn the area completely but left a few clumps of trees and narrow fringes of spruce around several bogs. These are used by moose in summer as resting sites. During the 4 years of the study, 2,923 adult moose were classified by sex. Bulls comprised 61 per cent of this total. However a separation of the observations into May-August and September-November components gave quite different results. These were:

	Adult Moose	Per Cent Males
May to August	1,381	78
September to November	1,542	52
Total	2,923	61

During approximately the same period, Earl Penney, a truck operator in the area, kept a record of his moose observations for me:

	Adult Moose	Per Cent Males
April to August	162	52
September to November	291	55
Total	453	53

The road that Penney traversed daily parallels the study area for 3 miles and is approximately the same distance way from it at the closest point. However, the habitat through which it passes is well wooded, with many small openings, some natural others the result of pulpwood-cutting operations. (This is fairly typical of the range on which many moose were observed in the Western, Central and Eastern Districts.) It appears that the variable behavior of the sexes in the use of open habitat has influenced the study-area data.

Cowan (1950) showed that females predominated in several big-game species on overstocked range. However, in the case of moose, his data showed a higher percentage of bulls than of cows. He indicated that the data were possibly biased, since bulls use a more open habitat in summer and are easier to observe. Similarly, although the Newfoundland data indicate a male predominance on the poor range of the Southern District than on the good range of the other three districts (Table 7), it seems likely that this higher percentage is related to the variation in behavior between the sexes in the use of this habitat. (The range in much of the Southern District is of a very open nature, with forested river valleys grading into tundra-type vegetation at elevations of only a few hundred feet.)

The fetal and calf-mandible data present the best evidence of a male predominance in the population, but the fetal data do not show a significant departure from 50:50, and the vulnerability bias may have affected the calf data. Taber and Dasmann (1954) showed that male fawns of black-tailed deer *(Odocoileus hemionus)* wander farther from the doe and are more vulnerable to trapping than female fawns. If male moose calves behave similarly, there is more possibility of their being shot than female calves.

I conclude that sex ratios of the kill are probably not a reliable indicator of the sex ratios of a moose population. There may be a small preponderance of males in the Newfoundland moose population, as the observational data indicate, however, with so many indications of existent biases, one cannot be certain that the population sex ratio departs from 50:50. For this reason, further comparison with data from other areas is not warranted.

CONTROL OF THE KILL

Moose management in the Fennoscandian countries is almost entirely accomplished by control of the kill. In Sweden, although attention is being given to means of alleviating forest damage by regulating forest composition, this is not an established part of their moose-management program.

The ratio of moose killed in North America (Anonymous, 1955; Provincial Wildlife Departments, *in litt.*) to moose killed in Norway and Sweden is close to 1:1. On the other hand, a conservative estimate of the ratio of habitable moose range is at least 10:1. Although the higher moose kills in Sweden and Norway undoubtedly reflect greater moose densities and better accessibility of hunting areas, they are also the product of an intensive control of the kill. These annual yields of 20–25 per cent prove that moose on good range can be heavily exploited, a fact not generally appreciated in North America. Therefore, as North American hunting areas become more accessible, it should be possible to increase the moose harvest greatly —if control of the kill can be achieved first.

The most important requirements in achieving control of the kill are: (1) a flexible legal basis that permits a quick response of hunting regulations to the needs of management; (2) a sound knowledge of the local ecology of the species, particularly on such important points as productivity, range conditions and relative moose densities;

(3) a detailed knowledge of kill trends over fairly small units of range; (4) reasonable accessibility of the range. In Canada, at least, this accessibility frequently requires the co-operation of large forest-industry organizations that control private road systems. Since hunting regulations frequently reflect hunting sentiments, a favorable, or at least an acquiescing, public opinion is of prime importance. The high area kill of Newfoundland moose reflects progress in meeting these requirements.

Flexible Legislation.—The Newfoundland Wildlife Act gives the Minister of Mines and Resources power to adapt hunting regulations to management needs. Gabrielson (1955) wrote of this act, "It is a better basic law than those of most of the states studied by the Wildlife Management Institute in the United States." The zoning system and the any-moose regulations were introduced a few months after they were first recommended, in 1952 and 1953, respectively. In 1954, approximately 10 days after the recommendation was made, the length of the hunting season was extended in an area where the kill was below a desirable level. The Newfoundland public accepted the introduction of any-moose regulations without opposition. I attribute this to the fact that most Newfoundlanders live, or have lived, by harvesting a wild animal crop. They do not have the sentimentality common to people, particularly deer hunters, in many mainland parts of North America.

Knowledge of Local Moose Ecology.—Intensive harvesting of a species is frequently attended by fears that the species will be decimated. In Newfoundland, a comprehensive study (Pimlott, 1955) of range conditions and a reproduction study (Pimlott, 1959) were forceful arguments in favor of the premise that the moose population could be subjected to more intensive hunting. As a consequence, any-moose seasons were re-established for the entire island in 1955.

Knowledge of the Kill.—In North America, it is not economically feasible to estimate moose density for large areas by ground- or aerial-survey methods. The effect of the hunting program on moose density must be determined by population indices. Important indices provided by kill data are, area yields, hunter success, and average time required to kill a moose. In Newfoundland, the kills have been carefully watched for evidence of overharvest. For example, the kill in a 1,500-square-mile section of the Eastern District has increased rapidly and, in 1957, it was 1 moose per 2 square miles. It does not seem wise to limit the kill in this area as long as it continues to increase—these three indices will give evidence of overharvest before it can attain serious proportions. The population has a net rate of increase of between 25 and 35 per cent (Pimlott, 1959) and, even if overharvested, would soon recover when the kill was reduced. Kill reductions can be effected by the use of bull-only regulations that require proof of sex and that are well enforced.

Accessibility of Range.—Most of Newfoundland's good moose range is on land that is privately owned, or held on long-term leases, by two paper companies, the Anglo-Newfoundland Development Company and the Bowater Pulp and Paper Company. Both companies encourage hunting on their holdings, in some instances to the extent of providing accommodations for hunters. The report of a forest-reproduction damage survey (Pimlott, 1955) pointed out the hunter's importance to forest industry. It also has led to a better understanding of the mutual benefits to be gained by encouraging hunting on forest limits.

In previous sections, I have referred to "accessible" and "inaccessible" sections of the Newfoundland range. The terms are only relative—even in the so-called "accessible" range, there are large areas where roads, of any description, are 30 or 40 miles apart.

I believe that moose either have large home ranges or do considerable wandering. It appears that when intensive kills occur within limited areas, particularly on good habitat surrounded by poorer habitat, density is affected over a wide surrounding area. Presumably this occurs as the result of a gradual reshuffling of the population. Development of this hypothesis has been directly influenced by Wildlife Officer Arthur Butt's observations on the build-up of moose density in a section of the Central District (the Sandy River area) after heavy kills had occurred, and by my own observations on moose movement. The kill data, range observations, and a knowledge of the rate of spread in Newfoundland after the 1904 introduction have also influenced the development of this hypothesis.

Under present conditions of accessibility, the Newfoundland moose population can be controlled by hunting except in the most inaccessible part of the island—the southwestern interior (Southern 2, Fig. 2).

In the southeastern interior area (Southern 1, Fig. 2), control can be accomplished by the continued use both of long seasons and of any-moose seasons. If future kill trends and range studies indicate that the kill level is too low, it can be greatly increased by extending the season into the late-winter months, when men from the outports can use dogs and/or sleds to get into the interior to hunt. An incomplete knowledge of the status and winter distribution of caribou, no longer a limiting factor, previously made it difficult to work out late-winter seasons for this part of the island.

The control of moose in the southwestern interior (Southern 2, Fig. 2) has not been accomplished by hunting. Most of the kills are made within a few miles of the South Coast by hunters who travel by boat. There has been very little moose hunting in areas that can be reached only by aircraft. The local airline has only one operational base, Gander, and outfitters, because of the high transportation costs, have not found it feasible to establish hunting camps in this area. The human population is low along the coast, and winter access is so difficult that the extension of hunting into late winter is not likely to increase the kill greatly, although this has been considered. The presence of wintering caribou, which cannot sustain additional hunting pressure, compounds the problem. It appears likely that for some time to come the moose population here will be controlled by limitations of range and not by hunting.

SUMMARY

This Newfoundland moose study of sex ratios and of kill was based on collections of 2,017 mandibles and 561 reproductive tracts, on observations of approximately 7,000 adult moose, and on hunter-kill returns for a 13-year period, 1945 to 1957. Information and data for Sweden, Norway and Finland were obtained from Swedish and Norwegian publications and from *Svensk Jakt,* the Journal of the Swedish Hunters' Society.

Moose hunting began in Newfoundland in 1935; however the license sale was restricted until 1945. A hunting-season zoning system was introduced in 1952 and any-moose regulations in 1953.

Two types of hunting seasons are used in Sweden, the general season (of short duration and of unrestricted kill) and the special season (of long duration and with kill specified by total and by area). Norway and Finland have long seasons and similarly specify the total kill for each hunting area.

Dogs are used for hunting in the three Fennoscandian countries. Hunting methods vary: in one type, the dog is loose and brings the moose to bay; in another type, the dog is leashed and leads the hunter to the moose.

The moose kills in Newfoundland, Sweden and Norway have increased steadily. In 1957, the area yields were 1 moose per 5, 4 and 6 square miles, respectively. Sweden conducts periodic inventories of the moose population. The data, combined both from these surveys and from the kills, show that annual yields of 25 per cent of the fall population are common over large areas. These yields are as high as those for most heavily hunted deer populations in the United States.

The Newfoundland collections of moose mandibles showed that 40 per cent of the animals in the kill were calves and yearlings, and that

animals approximately 5 years of age or older comprised 23 per cent of the kill.

When hunter success and the average time required to kill a moose are computed for similar seasons and habitats, they can be used as indices of population levels. In the three comparable districts (Western, Central and Eastern), hunter success varied from a low of 47 per cent in part of the Eastern District to a high of 80 per cent in part of the Central. Hunters also required a longer time to kill a moose in the Eastern District.

In Newfoundland, Sweden and Norway, more male moose are killed by hunters than are female moose. Newfoundland fetal and observational data also show a preponderance of males, but to a less marked degree than the kill data. Sex ratios of animals in the kill are not representative of the sex ratios of the population, and a reasonable doubt exists that the sex ratio of the population actually departs from 50:50.

Newfoundland's success in obtaining high moose harvests is a reflection of the progress that has been made in obtaining control of the kill. The control is based on flexible legislation; a detailed knowledge of moose productivity, range conditions and annual kills; and on the co-operation of two pulp and paper companies that encourage hunting on their holdings.

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DISCUSSION

DISCUSSION LEADER KING: I want to congrateulate Dr. Pimlott on a very complete and detailed paper.

MR. GEORGE SELKE [Commissioner of Conservation, Minnesota]: I notice quite a few references, Dr. Pimlott, to depredations caused by moose in regard to the forestry program. What do they damage? What do they browse on, and so on?

DR. PIMLOTT: On Newfoundland ranges, the two most important foods are white birch and balsam fir. Over quite large sections of the range white birch is actually being seriously affected as an economic tree species by moose browsing.

We conducted a study on the effect of browsing on the reproduction of balsam fir and found that in quite a considerable section of the range the reproduction in the low-density plots was being quite seriously affected by the moose. Since that study the hunting intensity has increased, and I believe that this problem is not going to become more serious. However, there is considerable concern in Newfoundland at the present time, and the two paper companies are now considering joining with the Government in a program to make a complete browse analysis, or forest damage study, for all of the parts of the Island where there are economic forests.

MR. BRUCE WRIGHT [New Brunswick, Canada]: I haven't a question to ask but I would just like to make a comment. I would just like to point out that Newfoundland is the newest province of Canada. It is not one of our wealthiest provinces, but I would like to say that we owe them a tip of the hat for really getting cracking on wildlife management. This job that you have heard Dr. Pimlott discuss today is perhaps outstanding in all of North America and, coming from the new province and starting right from scratch, I think Dr. Pimlott should take a bow for having done a magnificent job.

WHOSE SPACE, AND FOR WHAT?

ARTHUR D. SMITH

Utah State University and
Utah State Department of Fish and Game, Logan

This is the space age, or so the headlines constantly remind us. Plans are in the making to project man to the moon, Mars, Venus, and even beyond. While I do not expect to make one of these interplanetary journeys, I have lived long enough and learned enough not to stick my neck out and doubt that some of you here may do so.

But, though some of you here may witness the fruition of these plans, most of us will continue to be earthbound. However greatly we may be affected by the conquest of, or controversies over, outer space—our elbow room will continue to be dictated by what takes place upon this planet. My belief is that there will be no mass exodus to other celestial members that will relieve the relationship between man and the land available on the earth. It is pradoxical that we are engaging in a race to conquer outer space before we have solved the problems relating to the land resources already at our command on the earth. Pressures for land are increasing and will, perhaps, become more intense.

Entirely accurate predictions of future populations are, probably, not possible. Nevertheless, predictions constitute our only basis for planning. Although the projections may be in error, it seems likely that they will err only as to time, not as to total numbers. The possibilities as now seen are staggering.

Bureau of the Census figures indicate the following possible future populations in the United States (Barlowe, 1958):

1965 — 186.3-193.3 million,
1970 — 196.4-209.4 million,
1975 — 206.9-228.5 million.

The present population is in excess of 175 million. United Nation's estimates are that the world population will be 3.3 to 4 billion by 1980. This is an increase of 27-53 percent over our present numbers (Brown *et al.*, 1957). These increases pose problems of production of food and fiber, residential and industrial space—problems which require careful consideration. I do not wish to spend time with these, but upon the problems that will arise in trying to meet the demands of the increased populations for space in which to satisfy recreational needs through hunting or other forms.

To a considerable degree, the problems to be solved in meeting the demands for satisfaction of these needs arise out of our land policies. Land measures, like Topsy, "just growed," specific laws being adopted to meet needs and circumstances which, at the time, were pressing. Little evidence exists that, in many of these land acts, much consideration was given to fundamental philosophical ideas of the relationship of land to man's welfare. The viewpoint, in large measure attributable to Thomas Jefferson, that individual land ownership was necessary to insure the freedom of the individual, was an exception.[1] This philosophy, which has been prominent in our land policies, was a natural outgrowth of conditions in the feudal system, from which the colonists were trying to escape, wherein the landlord owned all the land and, through it, the individual as well. The validity of the Jeffersonian philosophy was dependent upon two conditions—the economy was to remain chiefly agricultural, and the supply of land was to be unlimited. Neither of these conditions persisted. Our economy did not remain chiefly agricultural, as evidenced by the decline of the farm population from 94 percent of the total in 1800 to 15 percent in 1950 (Barlowe, 1958). Demographers assure us that this decline is not at an end. Despite this reduction, it cannot be claimed that our democratic processes have been weakened by it. Our present industrial economies do not lend force to classical arguments regarding the role of property in insuring democracy; and many present-day disciples of Jefferson would find his graduated land tax a shock, were they to learn of it.

Furthermore, even though that philosophy was valid, the many land disposal measures provided opportunities for restriction of the land-owning privilege. Sales favored the person with ample means. Dummy entries and misrepresentation under the homesteading laws permitted large holdings to be acquired. Contrary to the purpose of the acts, the very measures designed to foster moderate-sized holdings by the individual permit the acquisition of large holdings by the few. So long as open land was available to the settler, this fact could go unnoticed. Now that free land no longer exists, dollars of low utility in the hands of the affluent can outbid the newcomer for land. The result is to limit, not to increase, opportunities for land-holding.

Concomitant to this philosophy of ownership of land by all the people, was the view that in this wide distribution of the land-holding privilege lay the greatest social welfare. This argument, briefly stated, is that since the individual would profit most from land ownership, the maximum benefits to society would necessarily follow.

There is ample evidence to show that individual and group welfare are not coincident. On the face of it, this appears to be an argument

[1]But, as Schlatter observes, even Jefferson was forced at times to abandon his view that the right of property was inherent, and substituted "pursuit of happiness" in place of "property" in the Declaration of Independence. (See R. Schlatter, *Private Property: The History of an Idea.* New Brunswick: Rutgers Univ. Press. 1951. pp. 195-198.)

that the sum of all the parts is not equal to the whole. Closer examination will make clear that this view is a spurious one.

In the first place, by reason of a greater time preference—which for simplicity may be taken to mean the length of time over which future use or returns have value—society can place a greater value on future use of resources than can an individual. No one here will value or place any value on a promissory note which can only be called beyond his lifetime. However, any community to which any of us may belong will be here beyond the lifetime of any one of us. The total of all the annual returns to which the community can look forward is thus greater in the case of the group than it is in the case of the individual. This is true even though the rate of use adopted by the group to insure a long period of returns is less than that adopted by the individual. This factor has had much to do with the improper use of resources under individual ownership. Thus, the apparent anomaly is explained by the fact that the individual does not deal with all the parts of a whole. His evaluations are based upon a shorter time interval. Rates of resource use can, therefore, be lower for the group than for the individual. The result is that the resource lasts longer and the total of its annual yields is greater. A rate of use of 10 for 200 years is greater than a rate of 20 for 50 years.

Another factor which operates to make community returns greater than individual returns is that the individual is not in a position to perform the entrepreneurial functions for all land resources. One example may illustrate this problem, although all land resources are not identical to water in this respect. Water is one of the most important of land resources. This is especially true in the West. The individual cannot manage land for water production with the hope of a profit. No economic mechanism exists for compensating the individual, for the relationship between producer and consumer is too tenuous. Water which enters the aquifers in the Rocky Mountains appears as ground water far to the eastward on the Great Plains. An individual owning land in the region of infiltration is not likely to have much concern for the welfare of the prairie farmer who recovers this water from wells. Nor, if he felt such concern, is there any means of rewarding him for adopting land measures designed to promote infiltration, in contrast to his neighbor who feels no such concern. To the individual land-owner in the Rockies, no value attaches to this fraction of the land. To society, there is a great and important realizable value to this water. Again, as in the case of resource use over time, the sum of the individual values of resources in land is less than the sum of the values of the same resources for society. Simply, society can claim as credits more of the resources that land has to offer than can the individual. Similar relationships exist with other resources such as game animals and recreational values, although they differ in degree.

These two factors, coupled with the increasing scarcity of land, provide the case for a re-examination of our land policies. Rights in land should be so distributed that maximum opportunity is afforded for the realization and enjoyment of all the resources which land embraces. Land should be regarded in its entirety and consideration given to all the possible sources of satisfying human needs. Where water production is an important product, where game animals are present, and where scenic values exist—these should be included in the catalog of land values and measures should be taken to insure their productivity. But unquestionably these uses will come into conflict with other resources which also have value. We cannot produce big game animals on an area in maximum numbers, and superimpose livestock upon that use. If the numbers of each are reduced somewhat, so as to bring total stocking within the capacity of the area, fewer of either animals will be supported than if only one were present; but the total yield from the land will doubtless exceed that that would exist if only one kind of animal were present. To a greater or lesser degree, this is true with all multiple resource uses.

Admittedly, some resources are not mutually compatible. Livestock bedgrounds make unattractive picnic sites. Within the limited areas where intense recreation uses are required, most—if not all—other uses must be excluded or sharply curtailed. The necessity for supplying forage for game on a critical game range may require livestock reduction there. Multiple-use, then, must be the integration of uses within an administrative land unit—not the superimposition of one use upon another on the same tract of land. Multiple-use may be more an administrative than a land-use concept. In the present rush to get on the bandwagon of multiple-use, this fact is often overlooked or is consciously ignored.

But how can these several uses and resources be allocated in order to provide for the maximum of returns from the integrated products of the land? Under public ownership, this is theoretically possible. Given sufficient facts and clear administrative authority, each use will be accorded proper consideration in terms of the social need and the physical relationships of the resources themselves. Probably we can only approximate this ideal.

Under private ownership, full use of land resources may be difficult or impossible. Land use is determined by individual desires; and these may be motivated by monetary returns, preferences, or mere convenience. Dairy agriculture may be the most productive use of a farm. Dairying may not appeal to the particular person involved and he may, therefore, produce some other less productive crop of less monetary value to him and less needed by the group. Moreover, he may be entirely unconcerned for the production of some game animal which might be made more productive without interfering with the use of first interest to him. On the other hand, land may be acquired for the purpose of producing only game animals to be hunted by a limited and select group, without regard to other resource values such as timber, forage, or foodstuffs. Conceivably, this single preferred use may be the one to which the land is less well-suited than another. Such conditions may be permissible while land is plentiful. As land becomes scarce, we can hardly remain indulgent in such matters.

A natural consequence of this view is that first priority, assuming comparatively equal need for the different products of land, be given to those uses to which the land is best suited. Much of the difficulty attending damage to land can be traced to permitting, just because it has priority in time, some use to which land is ill-suited. Grazing in the West is an example. Many of our grazing problems can be traced to the fact that we have permitted livestock on areas not properly grazable. Few areas in the West exist which do not provide some cover of plants which animals will eat. Many of them, however, because of steep slopes, loose soils, or other factors, cannot continue to produce herbage without damage to the soil under the impact of grazing animals. A major and, sometimes, almost sole factor in the reductions of grazing levels in the West is the fact that areas have customarily been grazed when no grazing should have been permitted. Such areas must be removed from grazing use.

Where, however, no such dangers attend use, grazing constitutes one of the important land products. Moreover, in the West, the fact that much land has limited use other than grazing makes it important to graze those lands which are suited to it.

Another means of alleviating the problem of land scarcity is to place, insofar as it is practical, the managerial functions of the separate resources making up land where management and regulation is best performed. This approach requires that land not be considered as a single package, but as the sum of a number of packages to be distributed in the fashion best calculated to provide proper control and facilitate production. This may, at the outset, seem too revolutionary and certainly, in some cases, no easy means of distributing rights to the individual land resources may be found. We have, however, already done this to a considerable degree. Game animals remain the property of the state, even though they may be produced primarily upon private land. Subsurface rights are separated from surface rights in many instances. The recent mining law (Public Law 167, 61 Stat. 681) provides for retention of surface resources on mineral claims on public lands. It would be not far removed from this to grant rights for other specific uses only. We might, for example, permit the use of land for grazing only. The owner of these rights could not, as in the past, plow up the land for the production of wheat during a favorable cycle of moisture and prices, only to abandon the land when the favorable period was at an end. Moreover, we might make the right of occupancy subject to restrictions as to the kind of livestock, realizing that only one kind of animal can be permitted to use the land without damage to the other resources. In either case, the right to hunt and pursue game should be retained inviolate and not subject to the transfer with the other bundles of rights in land.

Such a course may be possible only in certain situations, even though upon a theoretical basis it appears to offer the means for maximizing returns from land. The integration of certain resources may entail conflicts which are not possible of solution where different owners are involved. Actually, this has—in a sense—been recognized and accounts for the present retention of certain lands in public ownership. Wherever the public interests are far more important than are individual interests, wherever the total product of the land can best be realized in public ownership, land should be retained under public control. Where individual interests outweigh public interests, private ownership may suffice. However, private ownership must be thought of in respect to individual land uses and resources, and not necessarily to the whole package of rights and resources which land possesses. A mining concern should be given the right to the capture of the mineral values, an oil company to the exploitation of the oil resources. The other land resources should remain the property of society, to be distributed in the interests of all. By treating land as a single entity, we have, in the past, sold the hair and given the hide and the carcass away with it for the same price.

The proposals made, while they may seem to be marked departures from past procedures, are not so revolutionary as might first appear. By retaining land in public ownership, we have recognized a basic problem; that is, where the principle value or values of land are of public interest, control over the land should remain public. Furthermore, we have recognized, even while we grant fee simple titles to land, that this is not a complete domain. By reserving the right of escheat, eminent domain, taxation, and the police power, we have established the fact that there is a public interest inherent in private land. If, then, the two extremes of ownership, public and private, be thought of as the extreme limits of the disposition of rights in land, then it becomes plain that all graduations of conditions may exist between them. Ownership of the resources of land can, therefore, be thought of as a continuum with a wide variety of conditions defining the distribution of the property-holding privilege. In any case, private ownership is not permitted to hold land against the welfare of the group. Even public land may have certain private rights which even the public may not deny. Between these extremes, "ownership" is divided according to the values that the land possesses. Where the resources are preponderantly of public interest, the ownership of the public is large and that of the individual is small. Conversely, as resources become more readily manageable by the individual, society needs to retain only those rights needed to protect the public interest.

The procedure proposed has been followed partially in the recent revision of the mining laws (Public Law 167, 84th Congress, c 375, 1st s.). This law provides that mining claims permit the pursuit of the mineral values only, and do not permit the use of the land for other purposes. Control of the surface rights remains with the government. There would seem no reason to suppose that such a division of resources could not be made permanent, rather than as at present issuing a patent which passes surface control as well as control over mineral recovery to the claimant.

Admittedly, the fractionation of rights in the pattern proposed cannot be accomplished without creating some problems. However, this approach seems to offer the possibilities of insuring the maximum production from land—land that is becoming increasingly scarce.

It should be made clear that I am not proposing an attack upon our present landed institutions. What I am proposing is a point of view which tends to put our conflicts for land resources in perspective, and offers a means of resolving them. In this view, private ownership or public ownership are not the sole choices. Rather, certain rights and resources of land lend themselves to private exploitation. Others do not, but must be regulated by the group. As no land can be divorced from public concern, so perhaps no land is entirely without individual right. The problem is to determine the relative values and distribute the rights to the individual resources in such fashion as to best facilitate and promote the various values that land possesses. Working from our present land patterns, we can expect to evolve more effective measures to strengthen the rights of the individual as well as the group. But it is of paramount concern to retain flexibility in order to be able to make adjustments as conditions change. Land will change in quantity absolutely as well as relatively. Our needs for land qualitatively will change.

Probably Dana (1956, p. 349) did not have precisely the viewpoints expressed here in mind, but he does recognize the need for evolution of land policies to permit adjustment to changing conditions. He says:

> "The forest and range policies of the United States . . . have evolved gradually in response to stimuli exerted by ever-changing conditions. . . . The main problem today is not to invent new methods of attaining the goals which all agree to be desirable, but rather to sharpen the tools already in existence.
>
> ". . . National policy will always be a mosaic in a country characterized by private enterprise and a federal system of government, with ample opportunity for the free expression of diverse philosophies. Continual rearrangement and improvement of the parts of the mosaic can give the picture which it presents a steadily increasing unity and strength that bodes well for the future."

It is to give direction to this evolution and promote the adjustment to changing conditions and needs that the ideas in this paper have been presented.

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A DEER DRIVE VS. TRACK CENSUS[1]

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Tracks probably have been used since the beginning of mankind to guide hunters to game or to detect the presence of enemies. However, it has been only in recent years that serious effort has been made to determine population numbers from track counts. This paper attempts to relate the number of sets of deer tracks crossing roads to the total population.

Ruhl (1933) noted that tracks across fire lines appeared to give an index to deer abundance. As American wildlife management developed, it became apparent that deer census methods must be more reliable and less expensive than the drive techniques developed using CCC labor (Ruff, 1936; McCain, 1939). Apparently some workers were attempting census techniques using tracks, but without success (Erickson, 1940). At this time most wildlife census techniques were unreliable (Dice, 1941). Track counts were first used successfully by directly counting tracks of deer in a migrating herd (Wright, 1942). No serious attempts at determining populations of deer herds on their home range was presented until the early 1950's (Wright, 1951; Tyson, 1952).

It is not in the scope of this paper to discuss the reliability of the various census techniques. These have been reviewed in recent years by Dasmann (1955) and Taylor (1956). All methods to date have inherent fallacies, including the present track count technique. It appears that most workers consider the drive method the most accurate, but most prefer the strip census because it is less expensive. The present method is believed to be even less expensive, requiring only six man-days on the Eglin Air Force Base Reservation, Florida.

STUDY AREA

The Eglin Air Force Base Reservation covers an area of 461,117 acres (720.5) square miles) located in Santa Rosa, Okaloosa, and Walton Counties in western Florida. Of this, approximately 408,000 acres are forested and suitable for deer habitat.

Of the forested land, about 75-80 per cent is longleaf pine scrub

[1]A contribution from Pittman-Robertson Research Project W-27-R, Florida Game and Fresh Water Fish Commission, E. B. Chamberlain, Jr., Federal Aid Coordinator. I wish to gratefully acknowledge the assistance from the following men and agencies: W. Scott Overton with statistics and Lewis K. Jeter with track counts, both with the Florida Game and Fresh Water Fish Commission; Walker V. Spence, Supervisor, Forestry Branch, Eglin Air Force Base; and the many men furnished without which the drives would have been impossible; and especially to William Herndon, Forestry Aid for his invaluable aid in the conduct of the drives.

(*Pinus palustris-Quercus* spp.) broken only by scattered fluctuating ponds and spring "heads" up to 100 feet deep. Springs arising from these "heads" join and form clear cool creeks that meander through broad flat swamps. Flatwoods cover 10-12 per cent of the area, dominated by slash pine *(Pinus Elliottii)*, gallberry *(Ilex glabra)*, and wire grass (*Aristida* spp.). Swamps cover about 2-5 per cent of the forest, and the vegetation is primarily determined by the fire history. Recent burns, up to 25 years, are dominated by black Titi *(Cliftonia monophylla)*, after which the climax species such as magnolia *(Magnolia* spp.), black gum (*Nyssa,* spp.), cypress *(Taxodium distichum)*, and red maple *(Acer rubrum)* become obvious. Xeric and mesic hammocks dominated by oaks (*Quercus* spp.), and magnolia *(Magnolia grandiflora)* are scattered throughout the forest, especially adjacent to the swamps. Along the coastal fringes and the Scrub Hill section of Walton County, sand pine scrub (*Pinus clausa-Quercus* spp.) is common, intermingling with longleaf pine scrub, slowly replacing it in the absence of fire.

The terrain consists of gently rolling sand ridges extending from sea level to 196 feet on Sandy Mountain. The main ridge extends northeastward from East Bay into Walton County. All creek drainages are outward from this ridge; to the north they empty into the Yellow River basin and to the east and south, into Choctawhatchee Bay and East River. Outcrops of red clay are located in several places. Rocks are found only in the deepest creeks.

METHODS

Drive Counts—Drive counts were obtained by the method described by Morse (1943). This method required that each drive area be surrounded by roads where animal tracks could be counted. It did not require that spotters be placed at specific places to count deer, since deer leaving the area could be counted by their tracks crossing the roads. In this way all personnel available could be used on the drive line. Specific drive sites were chosen because that particular area was suitable and no effort was made to randomize selection; however, sites were in all forest types and well dispersed. A total of 34 areas was chosen comprising 20,040 acres or 4.35 per cent of the total acreage. All drives were made during January and February.

Several days before the drive began, roads around the drive areas were graded and cleared of all obstacles that might make tracks difficult to see. About half an hour or less before each drive began, a jeep traveled completely around the area with a drag designed to obliterate all tracks previously made. At the beginning of each drive the men were assembled and briefed on the shape, size, and nature of the terrain and vegetation. The number of drivers ranged from 29 to 53 with an average of 34 in 1952 and 47 in 1955. They were placed along the beginning roads at equal intervals, with the most reliable men spaced throughout to aid in keeping the men on course. The drive was started by a pre-arranged signal. Men were instructed to keep in a straight line and maintain equal distances.

At the end of each drive, two men walked or traveled by jeep around the plot to count the sets of tracks leaving the drive area. Another crew picked up the men to move on to a new drive area, and at the same time efforts were made to ascertain the number of animals that broke through the drive line.

Each year, 1952 and 1955, the same drive areas were worked, and drivers traveled in the same direction. It was the general opinion of the drivers that the deer count was fairly accurate, especially in 1955. At least, by this drive method each set of tracks represented a deer and population determinations from these data would be minimum.

Track Counts—This track count census method was first reported by Tyson (1952). However, due to the possible limited circulation, it is believed advisable to review the method at this time.

After studying census methods in use, it was concluded that a systematic analysis of deer tracks across roads would be the most practical method for the Eglin area in view of its many sand roads and dense vegetation.

In establishing the time of year for beginning a track count, the most important factor to consider was accuracy. After studying weather charts for the area and deer activity reports, it was decided that July and August would give best results. At this time the individual deer herds were breaking up and few trails were heavily used, and by mid-August fawning was in progress. Afternoon thunder storms were common and the rain blotted out all old tracks, and counts were made beginning about sunrise the next morning.

Large numbers of feral hogs were found over the entire area, and it was often difficult to distinguish between deer and hog tracks in the loose sand. A slow-moving jeep was used, and the driver did the track counting out of the side window, using a hand-operated tally register.

In analyzing the track counts it was necessary to know:

(1) The extent of a deer's range during one night, and

(2) relationship between the deer's beginning and ending point.

Considerable time was spent between 1950 and 1955 observing seven distinctive deer. Six of these had a daily range of less than one mile, and one, a white doe, ranged over about one and a half miles. These observations are somewhat greater than Progulske and Baskett's (1958) daily range of about one half square mile.

Of 38 deer trapped, marked, released, and retrapped between 1951 and 1955, only one was retaken more than a mile from the original trap site. Each animal was recaptured at least one time, and one buck was recaptured each year in the same trap. Trapping was done during January and February. These data on the extent of movement indicate somewhat less mobility than other studies (Hahn 1945; Hahn and Taylor 1950; Progulske and Baskett 1958).

During late spring, small bands of deer appeared to range over an area of about two miles in diameter, but by July the bands began to disintegrate. At that time each individual animal appeared to show evidence of a distinct home range averaging somewhat less than a mile in diameter, within the area used by the small bands.

Each of the distinctive deer was observed with groups and as individuals. During the hot months each animal spent the day within 100 to 200 yards of the same spot. A three-footed buck on Titi Creek spent almost every day on the same knoll overlooking a clay pit. A large buck spent every day for over a month within a small clump of sand pines within 300 feet of Windham Fire Tower. Just before sun-down each day he would leave the pines and go over to a small creek, yet still in sight of the towerman, only to return to the pines the following morning.

From these studies, two basic assumptions have been made:

(1) Deer usually return to the same location to spend the day.

(2) Nightly activity was confined within a diameter of about one mile (actually somewhat less).

Based on these assumptions, it can be seen that the population of deer within a circle, the diameter of which is "D" (average daily range), would produce two sets of tracks per animal on the circumference. Likewise, animals outside the circle would produce an equal number of tracks on the circumference if population densities were equal.

$$(1) \quad \therefore X = \frac{t}{4}$$

Where X = Total population within the circle

t = Total tracks on the circumference

$$(2) \quad \text{As } t_1 = \frac{t}{\pi D}$$

Where t_1 = Number of tracks per mile on the circumference then (as assumed above)

(3) $t_1 = \frac{4X}{\pi D}$ and

(4) $X = \frac{t_1 \pi D}{4}$ as

(5) $X_1 = \frac{X}{\frac{\pi D^2}{4}}$ and

Where X_1 = Population per square mile.

(6) $X = \frac{X_1 \pi D^2}{4}$

then

(7) $\frac{X_1 \pi D^2}{4} = \frac{4}{t_1 \pi D}$

(8) $\therefore X_1 = \frac{t_1}{D}$

Since any point on a circle may be considered a straight line, a series of connecting points on a series of circles would give a straight line. Therefore t_1 may be interpreted as the number of tracks per linear mile. Then as expressed in (8), the population per square mile would be equal to the number of tracks per mile divided by the average daily range expressed in miles. Then the average population per square mile "X_a" would be:

(9) $X_a = \frac{T}{D_t}$

Where T = total number of tracks and D_t = total number of miles counted, the total population "P" would be:

(10) $P = MX_a$

Where M = Number of square miles of range.

It is obvious that the most probable source of error is in the method of arriving at the average daily range. To date no satisfactory method of study for determining the average daily range has been devised, espcially in thick brushy areas where observations are difficult.

The presence of the roads on which the track counts were taken appeared to have little effect on the animal activity. Most of the roads had little day-time vehicular traffic and practically none at night. All roads were bare of grass and other debris, and it is improbable that many sets of tracks were missed on the bare, soft sand. All track counts in this study were taken on roads surrounding the drive areas.

TABLE 1. RESULTS OF DRIVE AND TRACK COUNTS, EGLIN AIR FORCE BASE

Plot No.	Acreage	No. Deer On Drive		No. Deer Per Sq. Mile		No. Tracks Per Mile	
		1952	1955	1952	1955	1952	1955
1	640	17	11	17.0	11.0	3.8	3.5
2	480	23	10	30.7	13.6	8.7	13.0
3	640	7	6	7.0	6.0	8.3	6.0
4	640	5	4	5.0	4.0	7.8	14.5
5	640	13	28	13.0	28.0	5.3	11.5
6	520	14	16	17.2	19.7	2.0[1]	11.0
7	480	7	4	9.3	5.4	16.0	9.5
8	560	13	14	14.7	16.0	39.8	18.3
9	800	19	24	15.2	19.2	52.0[1]	11.5
10	560	3	17	3.4	19.4	5.0[1]	6.0
11	760	2	5	1.7	4.2	11.5	20.6
12	600	0	2	0.0	2.1	0.0	8.5
13	640	7	4	7.0	4.0	5.0[1]	32.5
14	680	11	22	10.3	20.7	0.0[1]	14.0
15	400	1	2	1.6	3.2	1.0	21.0
16	1120	9	25	5.1	14.3	4.2	25.5
17	520	2	12	2.5	14.8	5.4	21.5
18	640	9	7	9.0	7.0	12.3	14.5
19	520	3	2	3.7	2.5	0.0	1.0
20	240	8	12	10.6	31.9	59.7	60.5
21	760	39	39	32.8	32.8	38.5	30.0
22	640	4	19	4.0	19.0	1.0	18.8
23	640	6	15	6.0	15.0	19.2	17.0
24	920	16	14	11.1	9.7	29.0	26.0
25	440	0	0	0.0	0.0	1.2	12.6
26	520	7	0	8.6	0.0	0.3	0.5
27	680	8	11	7.5	9.9	4.0	1.5
28	320	0	7	0.0	14.0	0.7	0.0
29	640	3	7	3.0	7.0	8.0	16.5
30	480	13	7	14.3	9.5	28.5	8.0
31	720	8	9	7.1	7.9	5.8	19.0
32	680	2	2	1.8	1.8	0.0	0.5
33	360	17	12	30.2	21.6	33.0[1]	16.0
34	160	1	8	4.0	32.0	6.0[1]	9.0
Mean				9.25 ±3.27	12.57 ±4.45	12.44 ±4.38	14.70 ±5.20
				95% Confidence Limit			

[1]Only one mile of tracks counted. All others were two or more miles.

Table 1 lists the results of all drives and track counts made. From two to five drives were completed daily, rain or shine. All track counts were made by two experienced men.

RESULTS

Number of Men vs. Plot Size—In 1952 when the average number of men used was 34, there was some evidence that the number of deer found per acre was influenced slightly by the plot size. In 1955 when the average number of men was 47 there was no evidence that plot size had any effect. There was no way to determine the number of deer that did not leave the drive area; therefore, it must be assumed the actual number of deer on the area could have been somewhat larger than observed.

Drives vs. Track Counts—It was assumed by the foregoing described method that each deer track represented one deer. By paired comparisons there was no difference at the 95% level between the number of deer found per square mile by the drive method and the number of tracks per mile. The Student t-test value was $t = 1.43$ in 1952 and $t = 1.00$ in 1955.

There may be several sources of error, namely (1) deer passed by drivers, (2) average daily range. Table 1 shows a difference in the means in 1952 and 1955 of 3.19 and 2.13 respectively. However, probable and expected errors would tend to decrease these differences or to indicate differences in a different direction; that is, there would be more deer per square mile than tracks per mile.

Effects of Weather—On cool, clear, calm days deer would remain bedded down until approached closely by the men; then they would run off ahead of the drive line, or if the driver was not close, the deer often remained motionless and later moved across the beginning road. This was evidenced by the number of crossings on the beginning road compared to the number of deer observed running through the drive line. On cloudy, windy, or rainy days deer appeared to be milling around ahead of the drive lines. They would often break through the drive line and sometimes break through from the rear. This behavior was probably due to the inability of the deer to locate the disturbance caused by the drivers during unfavorable weather. Wind direction had no apparent effect on deer behavior.

Effects of Habitat Types—Difficulty of travel by the drivers probably contributed more to the effects of habitat than any other factor. Several times while crossing creeks and surrounding swamp lands, the drivers tended to pile up in the less dense areas. There was no difficulty in track counting because the roads were all bare sand or clay.

DISCUSSION

This investigation indicates that there is a definite relationship between deer tracks across roads and populations. It is doubtful if the 1:1 ratio between tracks and deer will remain constant throughout the year even on the same areas. Wright (1951) found a ratio of 1.5:1 in New Jersey. Various factors such as vegetation type, populations, available foods, interference along roads, and others may cause changes. Some changes may increase while others may decrease tracks per animal per linear distance. Populations of any species that produce tracks may possibly be estimated by this or a modification of this track count method.

Track count census cannot be made without a knowledge of the range and habits of the animals. Since many factors affect movement, it is advisable to pick a period when tracks can best be counted and determine movement at the same time of year.

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DISCUSSION

MR. CHARLES M. LOVELESS [Florida Game and Fresh Water Fish Commission, Fort Lauderdale, Florida]: It might be interesting at this point how many man days of work are involved in this short test, as you call it, in this paper.

MR. TYSON: There are approximately 3,000 man days involved in this little 14-page paper. Originally it was about 25 pages and they kept requesting me to cut it down, so I cut it down and there are 3,000 man days in 14 pages and of those 3,000 man days about 2,800 of them were involved in making drives.

WILDLIFE CHALLENGES IN EAST AFRICA

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New York Zoological Society and The Conservation Foundation, New York

British East Africa, an area 1/5 the size of the United States and comprising Uganda, Tanganyika, Kenya and Zanzibar, is generally regarded as a part of the world populated with vast numbers of spectacular wild animals. Fifty years ago this was quite true, and in 1907, the railway running from the Indian Ocean deep into the interior of Uganda advertised that its "observation cars pass through the greatest natural game reserve in the entire world." But in more recent times, particularly since the end of the last war, the great pace of development coupled with an astonishing numerical increase in the African population have altered the natural environment until today, only a few restricted localities support significant stocks of large mammals. Not only are the remaining wildlife habitats being progressively reduced in size, but at the same time, relentless human pressure on the fast diminishing remaining herds—in the form of large-scale poaching—is having disastrous consequences.

To illustrate the significance of the current illicit slaughter of wildlife, it is necessary to explain that in the great Serengeti National Park in northwestern Tanganyika, which is generally regarded as the outstanding sanctuary on the entire African continent, a recent (1958) census has revealed less than 400,000 large animals of all species; this in an area where it has been fashionable to speak of millions of animals. It is important to note that this is the *only* wildlife concentration of its kind remaining on the entire African continent today, for there is no other place where even 100,000 head can be noted; yet 25 years ago there were several. To see this in its correct perspective, it is necessary to add that this figure is considerably less than the annual harvest of white-tailed deer in the United States. Furthermore, the Director of the Tanganyika National Parks estimated that not less than 150,000 wild animals were killed by African poachers in and around the Serengeti National Park in each of the last few years.

The recent major anti-poaching operation in eastern Kenya disclosed the extent of poaching of elephants in the Tsavo National Park and adjoining Coast Province. In one relatively small area, no less than 1280 elephant carcasses were discovered, and it was estimated that approximately 3,000 elephants have been destroyed by poison arrows in this region during the past three years. The peak seasonal elephant population in the Tsavo Park is estimated to be about 4,000, so it is very apparent that if poaching is allowed to persist at this rate, there can only be one outcome.

Several other species have had population reductions and are in jeopardy. Dr. Darling and Dr. Grzimek have each independently stated that they would be surprised if more than 1,000 black rhinos remain in Kenya today, yet only ten years ago, a member of the Game Department was employed to shoot over 900 rhinos in the Makueni area alone to make way for an African agricultural settlement scheme. In the Mara region, the finest lion country remaining in Kenya, there are not more than 250 lions today. This is the situation in a part of the world which many think is still over-run with wildlife.

The only hope for the future of wild fauna in East Africa lies in a two-fold program. First, the acquisition of basic factual data—at present noticeably lacking—on which proper long-term management programs can be based. Second, but equally important, measures must be taken to win the African over to the realization of the value of wildlife conservation.

The solution on which all else ultimately depends concerns the attitude of the African himself. For unless we take the effort in the years immediately ahead to alter the present attitude of the Africans, there can be no hope. The attitude of the more advanced African was adequately summarized by an African politician who stated that the presence of wild animals merely served to remind him of his own primitive past which he earnestly wished to forget. Therefore to eliminate this primitive past, it would ipso facto be necessary to destroy the animals with which that past was associated. The less sophisticated African has an insatiable craving for meat which can only be appreciated by those who have witnessed it. A combination of a rapidly expanding African population endeavouring to satisfy this craving for meat on a rapidly diminishing number of wild animals can have only one result.

If any effective long-term preservation plans are to be taken, it seems logical to suppose that the African must first be converted from his present attitude of mind and convinced of the value and worth of the fauna around him. This is nowhere near as simple as it sounds, but unless it is done there is little hope for the continued survival of wild animals outside the few national parks and sanctuaries. It is fundamentally impossible to put an end to the unnecessary and wasteful slaughter of animals without the active cooperation of the African himself.

It has been suggested that this could best be achieved by propaganda particularly in the schools through the medium of films, publications and lectures. This suggestion is admirable in so far as it goes, but even the most ardent protagonist of this form of propaganda must concede that it will be a very long time before such methods produce worthwhile results and by that time, there may be precious few animals left to conserve. After all, it is expecting a great deal to completely alter the inborn belief of countless generations of Africans that the only useful wild animal is the one in his cooking pot. By all means let every possible method of converting the African by propaganda be explored, but let it also be recognized that this is a long-term policy. How can an African conceivably become pro-game when he derives no benefit from its protection? How can he be expected to understand or appreciate aesthetic considerations or even that the preservation of wildlife is of great material benefit to the country as a whole? Many Africans, particularly the pastoralists, consider that they are expected to preserve wild animals on their own land for the benefit of a few wealthy Europeans and that they themselves derive no benefit whatever from the arrangement. This naturally causes resentment. There is only one argument to which an African can *at present* be expected to respond and that is the simple expedient of seeing for himself that he personally derives material benefit through the preservation of wild animals.

In East Africa, it is unlikely that wild animals will be allowed to survive for any length of time purely for aesthetic reasons and unless it can be shown that these wild creatures can contribute directly or indirectly to the economy, they will eventually be compelled to give way to more profitable enterprises and the inevitable needs of human expansion. In order to insure the survival of the greatest possible number of wild animals, it is necessary to remember their right to live will be largely judged in relation to their economic status. In the case of national parks, this condition is already fulfilled in that these parks bring in considerable revenue from the tourist trade. But the present system of national parks does not adequately conserve sufficient examples of East Africa's varied habitat and wildlife, and it is for this reason that game management zones must be created. In this connection, it is necessary to emphasize that this concept is based on the belief that certain areas of East Africa would yield a more profitable return to the country as a whole under wild fauna than under domestic livestock. This precept is undeniable, although it may not be easy to convince Government of its wisdom because of political and other considerations. The question is basically one of proper land utilization.

Ideally, each national park should be surrounded by a game management area (although this will not always be possible to achieve), the latter acting as a form of protective outer barrier for the central *kernel* of the Park proper. In these game management zones, it will be necessary to adjust our thinking and accept the fact that there is nothing morally wrong in harvesting an annual crop of wild animals in precisely the same way as a farmer has no compunction in marketing his excess cattle or sheep every year. This idea is well known to everyone present, but it is a new idea in Africa. At the same time, poaching might well be reduced to smaller proportions than is the case today. Furthermore, the African would be ensured of his meat requirements.

The only solution for maintaining significant stocks of wild animals outside of the protected limits of the national parks lies in some form of partnership with the African aimed at securing his cooperation through participation. He must be enabled to see for himself the direct benefits accruing from a sound wildlife conservation program. With this in mind, the Kenya Wild Life Society has proposed setting up a pilot game management project for the benefit of the Waliangulu tribe in eastern Kenya. This project is based on harvesting an annual surplus of wild animals on a sustained yield basis. It is in fact a protein-production project designed for regions entirely unsuited for domestic livestock or agriculture in the normally accepted sense, with all proceeds going to the African participants. Along these lines lies the future of Africa's unique wildlife heritage outside of the national parks.

The Waliangulu are a small tribe living in Kenya's coastal hinterland whose traditional way of life has been the hunting of wild animals. Until very recently, they hunted only for the pot and their own immediate needs, but have now taken to hunting on a large commercial scale, dispensing the ivory and rhino horn through a well organized ring of Asian receivers and leaving the carcasses of their victims to the hyaenas and vultures. As a result the Waliangulu are virtually poaching themselves out of existence by destroying their own means of livelihood. The Waliangulu poachers receive a mere pittance for ivory and rhino horn on the black market. As the average weight of ivory is 20 pounds per tusk recovered, the poacher receives something in the neighborhood of $25 per elephant; whereas an elephant, if properly utilized, is worth at least $300. If steps can be taken to legalize and *control* (on a cropping basis) the slaughter of elephants, the Waliangulu will be able to receive the full market value of the elephants and will, therefore, receive a far larger financial return for killing considerably fewer animals. By this means, their traditional way of life will be maintained, stocks of wildlife safeguarded for the future through proper management, and the black market run out of business.

There is a definite possibility in this area of utilizing existing wild animals as a form of continuing protein production for the benefit of the native inhabitants. In certain underdeveloped areas, chiefly arid and some tsetse regions, the harvesting of wildlife would be a far more satisfactory method of obtaining protein than would result from the farming of domestic stock. It would also be a wiser form of land use. In Africa, international development organizations have made considerable sums of money available for building up fisheries as a source of protein, but little if any thought appears to have been given to the possibility of utilizing wild animals as a productive source of protein for the benefit of the native inhabitants in areas notably deficient in proteins.

The time factor is most important; every possible step should be taken to commence this Pilot Project with the least possible delay. If successful there is no reason why similar projects should not be undertaken elsewhere for the benefit of other tribes. By this means the number of areas at present useless from the point of view of normal husbandry and merely serving as poachers' playgrounds could become highly productive, benefiting not only the tribesmen themselves but the country as a whole. At the same time, although almost incidentally, fresh zones would be created in which large numbers of wild animals would be enabled to survive for the benefit and enjoyment of future generations.

It would, of course, be out of the question to think in terms of instituting game management programs in heavily populated native reserves. Game management zones are suggested only for those arid semi-desert tracts which are never likely to be capable of supporting more than an extremely limited number of people and then only at bare subsistence level; in these zones, any form of economic animal husbandry in the accepted sense would be out of the question. Anyone who has seen this poor waterless portion of the country will realize that its wisest use would likely be in some system of game management. Wild animals have lived there for countless generations without damaging the vegetation and soil. Certain tsetse fly regions would also be eminently suitable for game management projects. It seems strange to think that substantial sums of money are being spent in eliminating species of wild animals eminently adapted to some of the tsetse fly areas in Africa and attempting to replace them with domestic animals which are entirely unsuitable, and which are unlikely to yield as big a return in terms of protein.

It has become apparent that if East Africa is to succeed in preserving its fauna, it is going to need the help of a small but permanent team of biologists who will increase the strictly limited knowledge of animal habits and requirements. This permanent research team might be started by obtaining the services of qualified United States, Canadian and British ecologists for specific projects. Here is an entirely new opportunity for field research of a kind never seriously attempted before in Africa *on a permanent basis*. Without the factual knowledge that trained biologists can provide, East African countries stand in grave danger of making faulty decisions and adopting wrong policies. In particular, the services of expert grassland and wildlife ecologists who will help increase knowledge of *range management* are needed.

East Africa possesses research organizations for most of its essential resources—agriculture, forestry, fisheries, and so on, but a similar organization for wildlife is noticeably lacking. This is because the conception of managing wildlife as a natural resource is a very new idea in this part of the world. It is a strange paradox that East Africa, which possesses the greatest and most varied wildlife resource to be found in the world, should possess so little essential knowledge on the requirements and needs of that resource. Undue emphasis is placed on controlling the kill, and not enough on understanding and managing the range and wildlife populations. Long-term wildlife range management programs have not yet been initiated in Kenya, Uganda or Tanganyika. In some European countries, and particularly in the United States and Canada, wildlife management problems which East Africa is only just beginning to comprehend, have been tackled vigorously for many years. Some of these solutions could, with necessary modification, be applied to parts of Africa. Our greatest—and one might add desperate— need is to establish facilities for a permanent faunal research organization in East Africa. The valuable investigations recently undertaken by Drs. Petrides, Swank, Buechner and Longhurst of this country, Dr. Darling of the United Kingdom and Dr. Grzimek of Germany, must be continued.

Unfortunately, there is insufficient local government money available to invest in a permanent wildlife research organization, for with very limited budgets, top priority in expenditure is invariably given to projects having more immediate benefit to the African inhabitants—schools, hospitals and agricultural programs. There is relatively little available for national park developments and the proposed wildlife management programs; for example, the total Kenya budget covering all government services last year was less than the funds allocated in this country for the National Park Service alone. The United States is the only country in the world with the will and means to provide assistance and technically trained men to begin a permanent wildlife research organization. This does not mean that East Africans intend to relieve government of any of its financial obligations, but rather that they should tempt government to provide for these additional new services on a matching basis. The United States not only pioneered the national park movement, but in more recent times has been instrumental in formulating and developing the concept of maintaining wild land as a recognized and legitimate resource. East Africa could profitably import some of the techniques so successfully developed in North America.

In summary, the present wildlife situation in British East Africa is critical and unless adequate measures are taken as a matter of urgency, another decade or two may well see the total elimination of wildlife in this part of the world except for scattered remnants in a few isolated token regions. In many parts of Africa, the effort to conserve wildlife has come too late. In ten years' time, it may be too late for East Africa. Wildlife management on a scientific basis is required as a matter of urgency. Technical and financial assistance are needed, for time is quickly running out on the most spectacular remnants of the world's wildlife. This state of affairs represents what may justifiably be regarded as the greatest challenge in the field of wildlife conservation since the near elimination of North American bison herds late in the last century. The next five years are vital because unless sound policies and practices can be determined and applied within that period, we shall have missed the opportunity which, if lost, will never be repeated.

DISCUSSION

MR. WOOD [Atlanta, Georgia]: I would like to ask the speaker what the financial outlay would be for such a program.

MR. SIMON: It is difficult at this stage to give a precise answer in terms of dollars. We intend to go ahead with this program on a staging basis. We intend to get a first-rate ecologist established in East Africa on a permanent or semi-permanent basis, with the object of directing and coordinating wildlife research activities in that territory.

We need in the initial stages, at a guess, something in the region of $100,000, but this is only the first stage. As soon as proper management programs have been drawn up, they will have to be put into effect in stages, and that will require more money.

DR. DARLING [Great Britain]: I didn't so much want to ask a question as to take this opportunity to pay respect to my old friend, Dr. H. L. Shantz, who went to Africa in 1923 and produced that very remarkable vegetation map of Africa, the first that was ever produced. He went there again, a very old man, three or four years ago, and he went over the same places, using that technique of his of taking photographs on the before-and-after principle. I am very, very sorry to say that he wrote me a long letter which was delivered to me by runner in a remote place in Central Africa telling me how very remarkable the degradation had been in these 45 years since he was there before; that is the degradation in vegetation owing to wrong land use and neglect of wildlife as a natural resource.

In Tanganyika, there is intense poaching going on. My colleague and I, during the last ecological reconnaissance we did there, reckoned there were 100 to 200 a week going out from 100 square miles. We made forays into this country and took prisoners—but what the devil can you do with them when you get them? There is no law to do anything about it, so we were breaking the law ourselves by taking prisoners. They were on the other side of the border where shooting with poisoned arrows is not an offense. On the Kenya side it is, but we were poaching ourselves by going over into Tanganyika and that is the kind of thing that is going on.

We thought there were 50,000 wildebeeste in that country. We made a very careful census indeed. There are only 15,000 and they are going fast.

May I just again say one word in respect to Michael Grzimek, who has so recently been killed in this same area and the work which Dr. Grzimek and his son Michael were doing there was absolutely splendid. Michael was killed a few weeks ago, as you know, and he was just the kind of chap we cannot afford to lose in this world.

DISCUSSION LEADER KING: Thank you, Dr. Darling, for your contribution and thank you also for your tribute to Dr. Shantz.

BIG GAME MANAGEMENT IN THE LAKE STATES

HARRY D. RUHL

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Big game management in the Lake States involves two kinds of areas—northern forest and the agricultural-industrialized, highly settled area. Because of widespread interest in deer and limited time, only deer management has been considered.

HARVESTING MECHANICS

Much research and management effort has been on mechanics to safely harvest a larger part of the vulnerable surplus. All sorts of combinations have been tried. A simple system of any-deer seasons of varying lengths and different opening dates may be the best for some, but may not be adaptable to other states because of differences in tradition and size of the hunting army and the deer herd.

A system of any-deer permits for any party of four hunters tried in Wisconsin last year does not provide geographical control of the take but utilizes additional deer and tends to distribute venison among more hunters than other methods.

Many states use a quota and area system of some kind for taking extra antlerless deer. Such a system operating concurrently with the general open season on bucks during the last 16 days of November seems satisfactory under Michigan's heavy hunting pressure.

In 1952 hunters in an any-deer season overlapping the last three days of the 16-day buck season took an average of 18.5 deer per square mile in Michigan's Lake County area. Unrecovered losses, together with the take during the buck season, probably brought removal up to 64 per cent of the fall population. An annual unrestricted any-deer season might work for the remote areas of Michigan, but we do not believe it can be applied to our most accessible heavily hunted country without unnecessarily reducing the population level.

Some wonder about the cost of operating in such fine detail. In 1958 it cost Michigan about $12,000 for materials, printing, labor, and postage to handle 185,000 applications, conduct the drawing, issue 55,601 permits, print and send out 130,000 rejections statements, and to print and distribute 338,000 applications, 330,000 permit forms, and 320,000 circulars of detailed information. This seems a very reasonable cost.

MANAGEMENT

If management were content to take the surplus deer produced incidentally to other land manaagement and to make little effort to increase the carrying capacity of the land, then much of the attention would be directed to harvesting mechanics. However, if the policy is to adapt commercial timber operations on forest lands to carry more deer, then other types of research and management are needed. Unless efforts are made to improve game habitat on public land, the Game Department may find continued resistance to the full cropping concept.

The normal administrative organization tends to operate in a bilateral manner. Foresters trained primarily in timber management are grouped in one administrative unit. Game biologists primarily trained in game population dynamics and management, in another. Each tends to think primarily in terms of the specific field in which he is trained. The work pressures, specific problems, and the simpler aspects of single purpose management slow down the more difficult job of engineering multiple management. Multiple-use management is more complex and difficult and there are fewer solid guide lines than for either field alone.

A variety of cross ties between federal foresters, state foresters, and state game managers have been used in Michigan to develop multiple-use concepts. For example, special cuttings, flooding, herbicides, burning, disking, and bulldozing for wildlife have been encouraged on forest lands. Forest cutting and planting on Michigan state forests are approved by Game.

Too often, wildlifers either do not possess proven methods or are not skillful in making specific recommendations for well-defined situations. Trees stay in one place so they are more easily counted, studied, and evaluated than wildlife and recreation and are harvested and sold on a competitive market. Thus, their more tangible values may seem to outweigh the real but intangible values of wildlife—values which are difficult to demonstrate.

Oak management for wildlife will illustrate a concrete recommendation, based on research, which has been accepted by federal foresters in Michigan. In the north the oak followed forest fires and is of low quality. Many foresters considered this inferior oak a weed to be eradicated to make way for better timber species, although state foresters had been managing oak for wildlife for many years. The role of acorns in sustaining wildlife is easily understood and recognized by hunters, particularly where winter food is inadequate.

The United States Forest Service girdled some oaks in older plantations that over-topped and suppressed small pines and started to use aerial spraying to kill such oaks.

Special studies by game biologists involved actual feeding of deer and squirrels to determine the amount of acorns required by wildlife and measuring productivity of oaks of various species, sizes, crowns, and stand densities.

As a result both the United States Forest Service and state foresters agreed to leave at least ten of the larger, more dominant oaks per acre within one-half mile of deeryards and five per acre farther than one-half mile from deeryards, to encourage white oaks and to leave such trees on higher elevations to reduce frost damage. This formula was applied to timber cutting also.

Aerial spraying of pine plantations would not leave a desirable minimum number of oaks, so the United States Forest Service agreed not to spray ten per cent or more of each land description, leaving strips at least two chains wide.

Scattered poplar stands, too poor to attract commercial operators, offer another multiple-use opportunity. Some such stands may be due to deficiencies in the sites, but other appear due to other factors such as poor seeding following forest fire. Treatment by cutting, fire, herbicides or disking before the trees become too decadent can provide sprouts to feed deer, enough for diseases and insects, and a residue for future commercial cutting rotations which will work for deer and pay their own way. Here forestry and game interests are tightly inter-woven.

Some of the commercial pulp-using industries, such as the American Box Board Company, are promoting this multiple-use concept on privately-owned land. Your chairman is one of two men specifically trained in game mangagement who are employed by this company to plan cooperative multiple management on private land. These men have the knowledge and experience to demonstrate skillful management for both timber and deer.

The situation is a dynamic one as styles change in deer hunting as well as the use of timber for decorative and construction purposes. Analysis and research should be periodically evaluating multiple uses of the vegetative cover designs to determine the best arrangements for such things as timber, wildlife, the aesthetics, the need for variety by recreationists, and for the role of breaks in cover types which may be useful in controlling plant diseases as well as forest fire.

In the agricultural-industrialized area the major limitation on deer numbers has not been winter food as in the north. Fawn production is high and deer populations, although low, generally are spreading and increasing. Public intolerance to deer because of damage to farm and garden production, car collisions, fear of harvesting deer with high-powered guns in a settled country, and losses because of poaching, dogs, fences, and other activities of a high human population will determine how many can be maintained.

Disease relationship between deer and domestic livestock are particularly important in livestock areas. Farmers may blame an unaccountable brucellosis (Bang's disease) outbreak in his cattle on deer he sees in the pasture field or woodlot where the cattle graze.

All of 1,234 deer tested for brucellosis by a cooperative effort in Michigan were free of the disease. A number of other states also found that deer are unimportant in spreading brucellosis.

Leptospirosis is another disease which causes abortion in cattle. Its incidence among cattle in Michigan is not known but it has caused important economic losses in individual herds. Other mammals may be reservoirs and disseminators of the disease. Deer travel from farm to farm and could contaminate watering places since the (leptospira) organisms are shed in the urine of carrier animals.

Of 558 Michigan deer tested for leptospirosis, 20 per cent reacted in some degree, indicating the disease may affect deer. A joint study with Michigan State University is underway to determine what pathological effects, if any, occur in inoculated deer; and whether deer could be "possible carriers".

Over 3,000 deer were hit, killed by cars, and recovered in Michigan in 1958—886 in the southern agricultural zone. Damage to cars might be as much as three-fifths of a million dollars a year. A few collisions resulting in human fatalities could precipitate action such as payment of damages from game funds. If carried to its ultimate and applied to all wildlife, damage payments could use most of the money now available for management. Unless sound leadership is provided, removal by poaching and because of damages may limit the herd rather than legal harvest.

The time lag between an administrative decision to shoot antlerless deer in over-browsed areas of the north and public acceptance of antlerless seasons indicates how long ahead of action, serious discussion and planning for deer management in farming areas should begin.

Communicable stock diseases and damage are apt to be the Achilles heel of deer management in the agricultural-industrial areas.

Even though important improvements in management tools are made by biological and operational research, much is likely to depend on the judgment of the local land managers. The training and experience of such men should not be left to chance. Multiple-use training should begin in the colleges, but it also is a responsibility of the agencies. It should include planned shifting of employee from one field to another early in their employment to hybridize their experience. Systematic interchange of training, background, and experience between the action and the teaching group is suggested.

RESEARCH

Many states obtain fairly reliable figures of the deer killed each hunting season. From basic kill figures and accurate measures of deer ages, the biometricians probably can calculate total populations with fair accuracy. These can be determined to any degree of accuracy, depending on how much time and money is available and their use justified.

Other census methods, such as track counts, mail carrier surveys, and shining counts have been found almost completely wanting in Michigan.

Population figures based on kill statistics have been corroborated to some degree by the pellet surveys. This survey still presents some technical problems and is expensive—not alone in costs but in the time of qualified workers it consumes at a season already critical for game biologists.

Painful, but definite, progress is being made in the transition zone between direct census and the complex area of population dynamics. We have hopes of combining both direct and "index" census data with sex, age, and kill records and coming up with a *unified measure* of the deer herd—current, not historical, and dynamic rather than static.

Measuring available deer food on any range has been very disappointing. This doesn't seem difficult. Not only game biologists, but the plant ecologists, agronomists, and foresters are interested. Many plant ecologists are confident that they can reasonably measure plant communities although their systems have not yet been given a clean bill of health by the biometricians.

We compound the problem by asking what percentage of each community is available browse in the form of twig ends—and worse yet, how much has been eaten each winter. And, of course, this must be done in a simple fashion—something that a few generally trained biologists can do in a short while.

It appears that determining the amount of browse for deer, or the amount of browse deer have eaten in a season is an extremely complex problem, involving so many variables that it almost defies doing simply.

In Michigan we believe it could be done; but to do it may take tremendous effort.

Many of our difficulties are sampling problems. While moving forward at fair speed in adapting the methods of statisticians, we run head on into an age-old criticism of mathematics—does the theory really apply to the real world? Or simply, are we measuring what we think we are measuring? No amount of "stratified-random-sampling with-optimum-allocation" will get the answers we need unless the man in the field is counting what should be counted.

Often we can't measure directly what we need to measure. We must settle for study of related items such as age structure and hope to check our results against known "bench marks"—providing we can interpret the symbols on a bench mark when, and if, we find it.

So far feeding tests have been little more than finding what deer prefer to eat, and what combinations and amounts of browse will support them through the winter. Some have begun nutritional studies. At Cusino, for example, Michigan is beginning to verify a high infant fawn mortality shortly after birth which is related to the nutritional status of the doe. We are beginning to pin down previous suspicions that malnutrition in the deer herd may well affect the sex ratio of fawns.

Agencies often have enough grief initiating and defending seemingly direct and "so-called" practical research. They are apt to delay more complex aspects because of difficulty in demonstrating the need and practicable benefits. The obvious and seemingly easy items get attention first. Game Departments are prone to "let the Universities do it." Usually the Universities have no funds which they choose to allocate to this field and make every effort to make their wildlife research as "practical" as possible and for the same reasons.

A Game Department's responsibility for action makes it difficult to justify long range projects. The research program tends to bog down with "trouble shooting" to put out the "brush fires" that keep coming up.

Scientists, like most professional people, exhibit a pugnastic determination to pile up more data and explore new avenues—a useful attribute but it does make re-adjustment and termination of lesser projects difficult. Sugaring-off is a painful process to everyone.

PERSONNEL AND BUDGETS

It is easier to maintain personnel and budgets for the old established activities than it is to develop and sell the needs for new ones. Simpler, more direct phases of the management of land appear easier to maintain and increase than those that are new and complex. Unless systematic evaluation of all types of effort and results of each is developed, it may be easier to employ men doing more easily understood tasks such as tree planting, habitat improvement, fire fighting and enforcement than well-trained multiple-use land managers or researchers. All types are needed but the most efficient administration cannot be left to feeling or casual judgments.

Limited budgets in the conservation field during the next few years appear likely. It is, therefore, urgent that adequate analysis and research be made as to the need and relative contribution of personnel and funds *in all fields*. Efforts should be tested at *varying degrees of intensity* for each to efficiently determine the results and to effectively decide how much money should go into each. It is the only method tight budgets should tolerate. The tighter the budget, the more necessary the all inclusive, statistical sampling research and evaluation approach becomes. Statistical treatment and operational research appear promising approaches to many multiple-use problems.

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DISCUSSION

MR. TOM KIMBALL [Colorado]: I would like to ask Harry if he feels that our technology is ahead of our ability to sell our program to the general public and whether or not Michigan is getting the job done in this field of selling the general public the program once it has been developed.

MR. RUHL: We know how to do better than we are doing because we have resistance from people who do not understand, or feel strongly in opposition to what we are proposing. We think we are gaining but our heaviest pockets of resistance are the farthest away. They are changing, but not changing fast enough.

MR. KIMBALL: What mediums do you use, Harry, in trying to get that information to these pockets of resistance?

MR. RUHL: We use all we know how to use, radio, television, news releases, magazines, appearances, anything we can. We have to use, I think, all media of approach and you can't decide which one to use in a particular place unless you know the people. We will have to use them all because I think a good many people are listening to radio, or looking at television and aren't reading these days; and some people you have to talk to rather than write to them. Individual personal contact is the best but it is difficult o do. I hink we should expand and exploit cartoons and TV more than we do and more skillfully.

TECHNICAL SESSIONS

Wednesday Morning—March 4

Chairman: Robert B. Moorman
Extension Wildlife Conservationist, Iowa State College, Ames, Iowa

Discussion Leader: Ed Zern
Geyer Advertising Company, New York City, New York

EDUCATION AND PUBLIC RELATIONS

STRAIGHT ANSWERS ABOUT POSTED LAND[1]

Joseph S. Larson
Wildlife Conservation Incorporated, Boston, Massachusetts

The Commonwealth of Massachusetts, with over 500 people per square mile, is the most densely populated state in New England. In the 10 years between 1940 and 1950 the state's population increased by nearly nine per cent. The period since World War II has been characterized by rapid industrial expansion, birth and growth of housing developments, and wide expansion in the network of highways and roads.

To over 300 thousand persons who hunt and fish in Massachusetts this means that only a fraction of the state is open for them to enjoy their sports. Furthermore, this fraction grows smaller each year.

The hunter, who is most directly affected, is restricted to hunting on the small acreage of public land provided for his sport or on private land where the landowner is willing to permit hunting. Since public land open to hunting in Massachusetts constitutes only four per cent of the total state acreage, the sportsman is dependent on the good will of the landowner for the continuance of his sport.

[1]This is a contribution of the Massachusetts Cooperative Wildlife Research Unit, supported by the University of Massachusetts, the Massachusetts Division of Fisheries and Game, the U. S. Fish and Wildlife Service, and the Wildlife Management Institute.

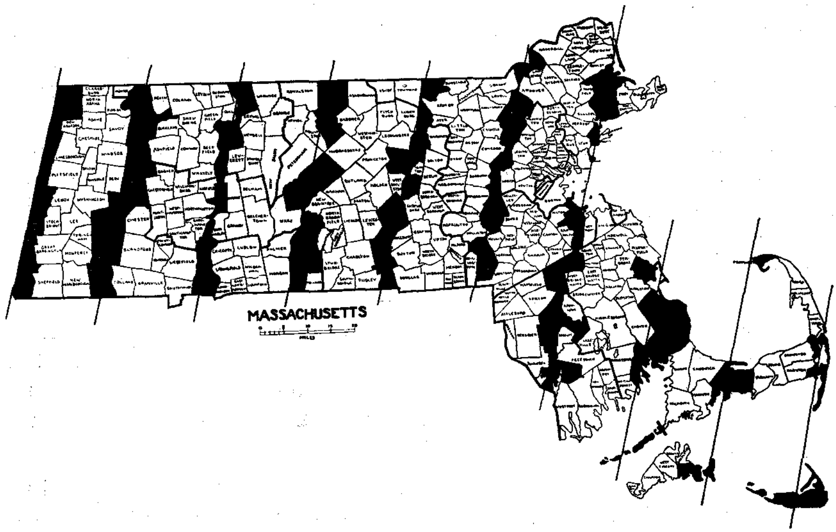
In recent years state wildlife personnel, outdoor writers, and sportsmen have expressed alarm over an apparent rapid increase in land posted against hunting and fishing. Programs to provide public shooting grounds were started, bills have been proposed to permit commercial shooting preserves, and "Safety Zone" projects have been put into action. These activities are designed to guarantee more land for hunting and to arrest the rapid increase in posting. However, until completion of this study, no information, which could be put to statistical analysis, was available about current posting in Massachusetts. Without such information there was no sound basis on which to combat the effects of posting.

The Massachusetts Posted Land Survey (Larson, 1958) was initiated to accomplish three basic objectives: an inventory of posted land in Massachusetts, on a sample basis; determination of the primary reasons for posting land; and presentation of suggestions leading to a possible solution of the posting problem.

The initial problem in the survey was to secure a valid sample. Studies and surveys of posted land which were conducted in Kentucky, New Hampshire, Ohio, Oregon and Massachusetts were reviewed to learn the methods used in those states. It was found that no published method would yield a statistically sound sample of the type desired. Mailing lists to farmers were examined, but these proved to be equally inadequate. An examination of the tax records of the cities and towns, however, showed that these would provide the source of a sound sample. The index used to determine whether any land holding was suited to hunting was acreage. It was decided that 10 acres, in one solid block, would be the minimum acreage allowed in the study. Later it was decided that a 20-acre minimum block would have been more desirable.

A two per cent sample of the Massachusetts landowners owning hunting land was deemed sufficient to test statistically. It was decided to secure a 20 per cent sample of the cities and towns of the state and to take a 10 per cent sample within these chosen communities. This would yield the desired two per cent overall sample. By recording the name and address of each landowner owning 10 acres or more, in a single block, whose name fell on every tenth page of the tax records, a 10 per cent sample within each community was easily secured. Difficulty arose in designing a 20 per cent selection of cities and towns which would yield a good geographic distribution. A random sample did not produce the desired geographic distribution, so a new approach was developed.

In the field of forestry, the number of trees in a large forest is never known. To learn something of these trees, one takes a sample



Fgure 1.

based on known values, *i.e.*, the known acreage they occupy. By running a series of strip cruise lines across the forest, one assumes that if the strips occupy 10 per cent of the known area, 10 per cent of the trees have been sampled. This principle was applied to the state to obtain a 20 per cent sample of cities and towns. Ten cruise lines, spaced evenly across the state, yielded 10 strips of cities and towns running roughly north and south (Figure 1). This selection resulted in a 22 per cent sample of the communities in Massachusetts. The lines were not run east and west since in the final analysis it was desired to compare eastern, central, and western regions of the state and east-west lines would have made separation on this basis more difficult.

A trial survey was conducted on three representative communities to test the sampling technique as it applied to sampling within the communities. A one page mail questionnaire was sent out early in August of 1956 accompanied by a cover letter and a self-addressed, stamped envelope. After two weeks elapsed a post card reminder to those who had not responded was sent as a follow up. The 62.9 per cent return indicated that this method should be applied state wide.

The state-wide mailing was sent out in mid-October, 1956, to the 1165 landowners selected in the final sample. This also consisted of a cover letter, a questionnaire utilizing one side of one page (Figure 2), and a self-addressed, stamped envelope. First Class mail was used

QUESTIONNAIRE

How many acres do you own? ______

(If you have a tenant or other person In actual charge of your land who can give the information below more accurately, please write his name and address on the back of this sheet and return it to us.)

2. Do you post your land? YES ☐ NO ☐ How much is posted? ______

3. Is there any water on or bordering your land, like a brook, stream, marsh or pond?
YES ☐ NO ☐

IF YOU DO NOT POST YOUR LAND, SKIP TO QUESTION NUMBER 5.

If you answered "YES" to No. 3, do you post the water area to prevent (Check ones that you **do** post against):

a. Swimming ☐ c. Fishing ☐
b. Trapping ☐ d. Boating ☐

e. Any other you post for in the water area: ______

4. Do you post the rest of your land, other than the water areas, to prevent (Check ones that you **do** post against):

a. Trespassing ☐ d. Camping ☐
b. Hunting ☐ e. Picnicking ☐
c. Berry Picking ☐ f. Any other you post for: ______

Please state here the chief reasons for your posting: ______

5. If you do **not** post your land, or parts of it are not posted, please state why you have not felt the need to do this:

6. If your land is posted, would you permit persons to use it (as in questions 3 or 4) if they first asked for your personal permission? YES ☐ NO ☐

Comments (Use back of sheet if you wish):

Figure 2.

throughout. Again, after the elapse of two weeks, a post card reminder went out to all non-respondents. By mid-February, 1957, a 50 per cent usable reply had been obtained. At this time a second letter and questionnaire were mailed to the non-respondents. By spring of 1957 the final mail response stood at 69 per cent. In the case of returns which indicated the landowner was deceased or that his land was definitely not hunting land, alternate names were used.

To check the validity of the mail response, and to determine if the non-respondents formed a significantly different group from the respondents, personal field interviews were conducted among a sample of the non-respondents. The data obtained by personal field interviews did not differ significantly from the data received through the mail. This indicated that the non-respondents were not a different class of landowners and that the mail information was as valid a response as a personal interview, in this study.

Data were entered on a hand sorted punch card system similar in design to many that are in common use today (Adams 1950). Information was tabulated by cruise line and subject to standard statistical tests (Snedecor, 1956). The test most frequently used was a variation of the chi-square test, known as interaction chi-square. This test determines whether the data collected came from the same or different populations. The 95 per cent level of probability was used.

Analysis of the data showed no significant difference between residents of the state and non-residents as far as tendency to post is concerned.

To determine how much land is denied to the sportsman, it was necessary to determine how much of the state was denied due to reasons other than posting. By utilizing the vegetative cover maps of the state (Garvin, 1955) official tabulations of urban and rural road mileage, plus tabulations of publicly owned land, it was possible to determine the status of all the land in the state insofar as hunting is concerned. It was shown that nine per cent of the state is "urban" land in cities and towns and thus lost to hunting. An additional nine per cent is lost due to roads and the restrictions on discharge of firearms on or within 50 yards of a state or paved highway. Three per cent of the state is publicly owned land which is closed to hunting and four per cent of the state is publicly owned land which is open to hunting. This leaves 75 per cent of the state acreage in the category of privately owned land probably available to hunting.

Data analyzed in this survey and applied to the above tabulations shows that posted private land comprises 20 per cent of the total state acreage and 55 per cent of the state area is unposted private land. In summary, a minimum of 41 per cent of Massachusetts is now closed to the sportsman. The term "minimum" is used advisedly since this survey could not take into consideration the law which prohibits discharge of firearms within 500 feet of a dwelling without permission of the landowner.

A good deal of speculation has centered about the amount of posted land which could be hunted if permission is first requested. An important aspect of this survey was designed to answer this question. It was discovered that 59 per cent of the landowners who post their land will allow hunting and fishing if asked for permission first. Translated into acres, this means that hunters in Massachusetts who are willing to practice common respect and courtesy have the opportunity to hunt and fish on approximately 600 thousand acres of presently posted land.

The Massachusetts Posted Land Survey also established the main reasons for posting land. The most frequently given reason for posting was destruction of property. The second most important reason was discharge of firearms too close to buildings. These two reasons combined accounted for more posted land than did all the other reasons combined. Most persons who did not post their land had had no trouble to date, but the second largest group of non-posting landowners explained their action by saying that they believed that their land should be open to those who wish to hunt and fish. This was indicative of the basic generosity of Massachusetts landowners which the investigator encountered throughout the study.

In recent years, nearly 20 towns surrounding metropolitan Boston have seen fit to control hunting by legally closing the towns, through passage of a town by-law, to discharge no firearms. This is posting against hunting on a large scale. Through interviews with town officials representing a sample of these towns, it was found that the towns had closed for the same reasons given by individual landowners, *i.e.* destruction of property and shooting too close to buildings.

Recommendations to the Massachusetts Division of Fisheries and Game included the following: a more effective and extensive "Safety Zone" program, acquisition of more public land for hunting, creation of commercial shooting preserves, and an intensive education program designed to show the average hunter that he has a definite interest in discouraging poor field manners among his companions. To the Division of Law Enforcement it was recommended that their staff of enforcement officers be enlarged since they are presently understaffed. A special mobile force of officers was also recommended for use during times of stress such as opening day of the upland season and deer week.

The main overall conclusion is that posting is a situation which can be improved by the sportsman as individuals or in groups if they want to. The sportsman has everything to gain if he sincerely wants it, and in Massachusetts his reward for sincerity amounts to over 600 thousand additional acres to hunt.

These are the straight answers about posted land in Massachusetts and how they were obtained. Conditions in the remainder of the 49 states differ from those in Massachusetts, but the technique used in one state may well be applied with success in many other states.

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DISCUSSION

MR. RICHARD WEAVER [Michigan]: Would you be willing to tell us the cost of the survey? Is this secret information?

MR. LARSON: The information is not secret, if I had it. I can tell you, roughly, that the study was carried out under a Fellowship with the cooperation of the Wildlife Research Unit.

Most of the Fellowships are fairly standard throughout the States. A Fellowship of $1500 for the two years' study, and expenses.

The only additional expenses were printing and the mailing costs and traveling expenses, which I have not computed, so I am sorry I cannot give you a dollar figure. I could make an estimate later on, but not right now.

Perhaps the title of the paper made some people feel that they were going to hear from me the final answers to posting in the United States, and if you came in for that information, I am sorry, I disappointed you. I never intended to tell you how to solve the posting problem.

But I did intend to present a study which would be of interest to other administrators so that they might find some of the basic information that they need before they can attack a statewide problem such as posting.

The technique was more important than the actual results, except in the State of Massachusetts.

MR. MICHAEL HUDOBA [Sports Afield]: May I ask you to state some sample questions that were put to the land owner?

MR. LARSON: Question three was "Is there any water on or bordering your land like a brook, stream, marsh or pond?" I thought there might be some higher degree of pressure from the outside on land that had streams or ponds for fishing, but this proved not to be the case.

Then we said, "If you do not post your land, skip down to another question."

We included things like berry-picking, camping and picnicking to get information on those subjects, but also our cover letter never used the word "Wildlife," nor did it identify this study as anything except an ivy-tower study being conducted by the University. We kept away from using the words, "hunting and fishing," because some people already have preconceived ideas about hunting, fishing or about the State Game and Fisheries Division or about the U. S. Wildlife Service. We did not want to introduce bias there.

We asked them to state their chief reasons for posting, and then we said, "If you do not post your land or parts of it are not posted, please state why you have not felt the need to do it."

We felt that this information was equally as important as the reasons for posting.

The last question was, "If your land is posted, would you permit persons to use it if they first asked for your personal permission?"

We gave them a chance to check the block "Yes," or "No," and indicated if they wanted to add more material, they should add on the back of the sheets.

I should state here that we got a good deal of material on the back of these sheets from these people, and I felt the quality of the response was excellent because of their interest and taking the opportunity to give us a complete, rounded picture of their situation as they saw it.

DR. R. E. TRIPPENSEE [University of Massachusetts]: Joe did his work under our direction at the University of Massachusetts Cooperative, but that isn't why I am here.

I think we are dealing here with a very vital thing. It is not only vital from the standpoint of many conservation departments and many hunters and fishermen, but it is a part of our great American tradition, and if we lose free hunting, we are not losing just one phase of recreation for a narrow group of people.

I think that we should seek some way of maintaining this.

Now, many people who have viewed this over a long period of years have concluded that with airports and housing and roads and all of this, that, gradually, it is going to fill in and we are going to lose hunting, and we are losing it as you see by this so-called blob around Boston where whole towns are closing up.

Joe did not suggest a means of counteracting it, but I think as people who are interested in hunting and fishing, we should be thinking of that.

The clubs which are well organized might be one approach, but I am convinced that the clubs, even though they all took it up as a campaign, would not make too much dent in it, because there are a lot of other non-club people.

If you view the problem along with other problems, for example, the matter of the death on the highway, something like 40,000 a year, and the hammering that gets from everybody through television, radio and newspapers and so on, and yet we keep right on killing, but I do think that that is one approach.

I wonder perhaps if a catch slogan might be found that could appear in almost every program, and that the newspapers could take that up, that the clubs could take up, that would appear on television, just one simple little thing and then keep hammering at that.

Apparently, the problem is not too difficult, it is just a matter of courtesy. Can we, through the schools, through adult education groups, find that key and then apply it over a period of 20 or 30 years and perhaps arrive finally at a solution to the no-hunting problem anywhere? That is just a question.

THE CONSERVATION KNOWLEDGE OF VIRGINIA SCHOOL PUPILS[1]

ROBERT H. GILES, JR.

Virginia Commission of Game and Inland Fisheries, Covington

How effective is our conservation education program? How much knowledge of conservation are we "getting across"? How can we determine what Virginians know about conservation? What do they know now and what should we teach them? Where should we spend most of our time and money in order to teach conservation? These were the questions asked by conservationists and educators that resulted in a two-year research project designed to provide answers necessary for an effective, efficient statewide conservation program.

Several basic definitions will be helpful in facilitating your interpretation of the present investigation and thereby increase the usefulness of the results of the evaluation.

Conservation education is instruction and training that contributes to the public's knowledge of natural resources and to the wise use and management of these resources. The study limits itself to the renewable natural resources—soils, water, forests, and wildlife. Conservation, a word of controversial definition, is here taken to mean the wise use and management of our resources for the greatest good to the most people over the longest time.

By means of a recognition type of objective test with 100 multiple response questions, 15,443 Virginia public school pupils, both Caucasian and Negro, were tested for their knowledge of conservation. These pupils (five percent) were statistically selected as representative of the pupils in grades 6 through 12.

SIMILAR STUDIES

Five other workers have used objective tests to measure conservation understanding among school pupils. They were: Capps in 1939 evaluated 2775 tests of Missouri pupils; Curtis in 1942 evaluated 850 tests of California pupils; Glidden in 1953 evaluated 1021 tests of 23 states; Selim in 1951 evaluated 2325 tests of California pupils; and Wievel in 1947 evaluated 5000 tests of Iowa pupils. Mean total test scores, though differing, did not vary widely and tended to substantiate the findings of the Virginia study.

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[1]Release No. 59-4 of the Virginia Cooperative Wildlife Research Unit, Blacksburg, Virginia, the Virginia Polytechnic Institute, U. S. Fish and Wildlife Service, Virginia Commission of Game and Inland Fisheries, and Wildlife Management Institute cooperating.

THE TEST

The test selected as best accomplishing the objectives of the study was a recognition type of objective test with multiple response items phrased as incomplete statements. Each item contained five alternatives, four of which were distractors.

Items were prepared from a list of the principles of conservation prepared by the writer and the Virginia Cooperative Wildlife Research Unit. The test went through more than four reproductions before the final form was reached at which time it was printed for a preliminary testing program. Eight hundred and thirty eight tests were administered in the public schools of Blacksburg, Virginia and the results analyzed statistically and logically. Following this test administration, changes were made based on findings of its evaluation.

Items and test sections were arranged according to difficulty; items were discarded that were too difficult or too easy; distractors were randomly arranged; vocabulary was slanted at the sixth grade reading level.

Test validity was studied by several methods. Findley's (1956: 176-77) validity index was used and revisions in the items were partially based on these results. Each item was critically inspected for its ability to test for the knowledge of a principle of conservation. An advance in total test scores by school grade further indicated test validity. Based on the results of these three methods, the validity of the Conservation Knowledge Test was high for the purposes for which it was used, *i.e.* to test for pupil's knowledge of the principles of conservation.

Reliabilities for the final test were calculated by the Kuder-Richardson formula. Revisions made of the preliminary test did not change the total test reliability of .93. Reliabilities for test sections were also calculated and the following coefficients obtained: General, .949; Soil, .966; Forests, .938; Water, .861; and Wildlife, .943. Though the reliability of the Water section was low, it did meet the needs for which the test was designed. These coefficients indicate that the test is consistent in its measurement of pupil conservation knowledge.

A study of the I.Q.'s of 105 tests for the 838 tests given to the Blacksburg pupils showed that their mean I. Q. was 102. A correlation coefficient between the total test scores and I.Q.'s of the 12 percent sample was .22. This correlation is interpreted as indicating a small positive correlation between the I.Q.'s and test scores. The test seems to be further validated in that the test scores are not the result of pupils' ability to read or reason-out the answers. The slight positive correlation, however, may be expected because of (1) greater reasoning and reading ability, and (2) greater understanding or comprehension by pupils with higher intelligence quotients. The test scores, therefore, appear to be a result of the possession of, or lack of, knowledge of the principles of conservation.

A scatter diagram of the order in which pupils in the Blacksburg testing showed no correlation between test scores and the order in which pupils completed the test.

SAMPLING METHOD

Virginia has over 314,000 pupils in the public schools in grades 6 through 12. Twenty-three per cent of these pupils are Negroes. Of the schools having grades 6 through 12, there are 1338 for Caucasians, 660 for Negroes. Indian schools were not included in the study.

In order to determine the conservation knowledge possessed by these pupils, a representative sample was needed. Contacting the entire population was obviously impractical.

With the V.P.I. Department of Statistics, a proportional stratified random sampling method was adopted, and the following sampling technique used.

The state was divided into nine regions: Coastal, Piedmont, and Mountain; North, Central, and South. The population was further stratified by race and by school grades. An attempt was made to detect differences of 5 percent between horizontal strata and 3 per cent between vertical strata at the 95 per cent level of confidence. The sample selected represented 4.5 per cent of the pupils in Virginia public school grades 6 through 12. Sixty-nine schools were selected, sixty-one participated, administering the tests to 15,443 pupils.

SCORING AND GRADING

Tests were printed in booklet form and answered on an IBM form prepared for the test. Scoring was done partially by IBM test scoring machines and partially by grading overlays. Test sections as well as the total test were scored on the basis of a maximum score of 100 points . . . 100 per cent correct responses. Following the grading of the tests, data from each answer sheet was entered on standard IBM punchcards. The following information for each pupil was coded on cards: identification number, school number, score on each of the five test sections, total score, school grade, race, region and area, community residence, sex, and responses to items 103 through 132, the source of pupil conservation knowledge.

TEST RESULTS

Arbitrary item arrangement resulted in only 10 per cent of the

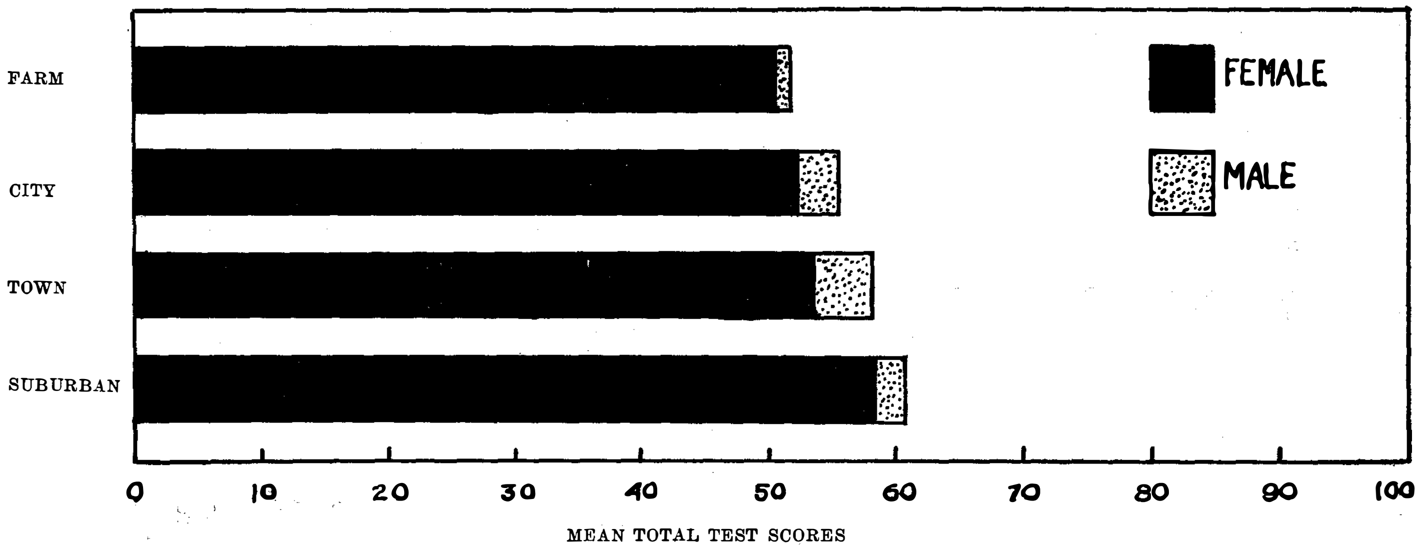

Figure 1. Conservation knowledge of pupils from different home environments.

TABLE 1. TOTAL CONSERVATION KNOWLEDGE TEST SCORES BY SCHOOL GRADE AND RACE

Grade	Race	Total Number of Pupils	Average Total Scores
	Caucasian	1806	49.7
6	Negro	661	37.1
	Total	2467	46.3
	Caucasian	2662	53.5
7	Negro	752	43.4
	Total	3414	51.3
	Caucasian	1804	58.7
8	Negro	1159	38.7
	Total	2963	50.9
	Caucasian	1668	64.8
9	Negro	649	44.1
	Total	2317	59.0
	Caucasian	1134	68.3
10	Negro	649	47.5
	Total	1783	60.8
	Caucasian	860	70.8
11	Negro	521	50.7
	Total	1381	63.2
	Caucasian	779	72.8
12	Negro	388	52.7
	Total	1167	66.1
Totals	Caucasian	10,664	59.9
	Negro	4,779	43.9
	Total	15,443	54.8

items being placed in their proper position of difficulty. The tendency (51 per cent of the time) was to rate items more difficult than they really were. Only 37 per cent were placed within ±3 positions of their final test order.

Pupils were asked to guess at their test score by "A", "B", "C", "D", or "F." Pupils generally did not do as well as they thought they would; the test was more difficult than most pupils thought.

The results of the final test do not compare favorably with other conservation tests in so far as home environment is concerned. Suburban pupils obtained higher scores than did Town, Large City, or Farm pupils in that order (59.4, 55.6, 53.7, 51.4). See Figure 1. The lower scores by rural pupils is surprising because of the apparent abundance of conservation education among agricultural people through the Extension Service, 4-H, and school agricultural courses and activities. The results indicate that suburban pupils have a greater knowledge of the principles of conservation than do rural pupils and may reflect in rural education over-specialization and emphasis on agricultural method and technique rather than on principles.

Test results by grades are presented in Table 1. Increase in average score through different grades was not constant. The greatest increase occurred between grades 8 and 9, next greatest between 7 and 8, and least increase between grades 11 and 12.

Though it is impossible to establish at this time a "passing" score

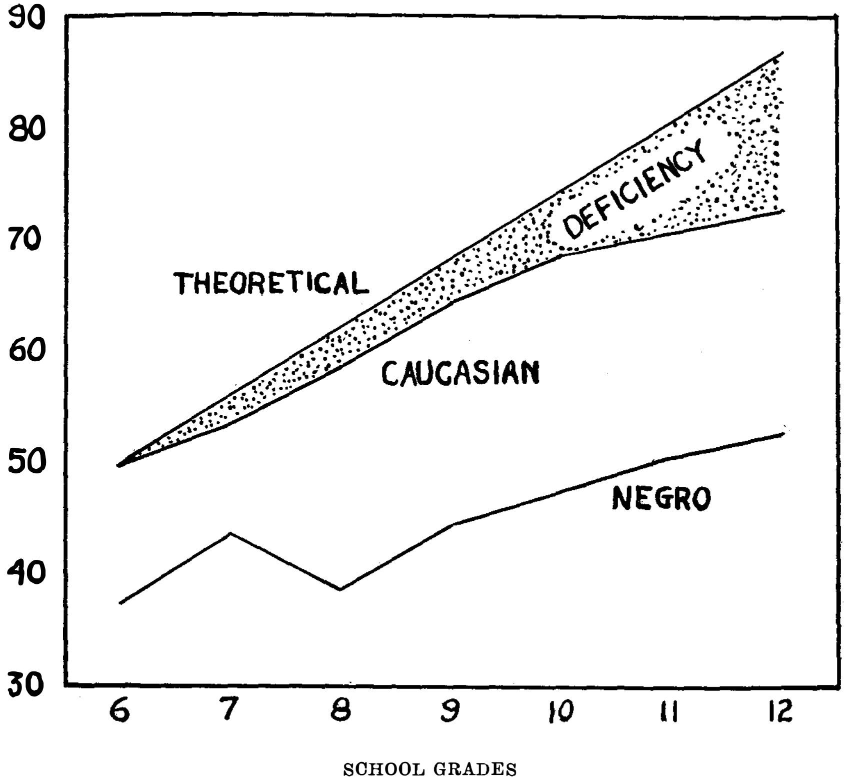

Figure 2. Pupil conservation knowledge within grades and races.

for the Conservation Information Test, it is possible to speculate on the figures obtained as they relate to conservation knowledge deficiencies.

The greatest differential between Caucasian grades was 6.1 occurring between grades 8 and 9 as seen in Table 1. Several assumptions are made about this figure. First, the Caucasian grade-score data was selected not only because of its regularity but also because it is representative of the greatest attained conservation knowledge at the time of the present study; second, that the increase of 6.1 per cent could occur between any grade, 6 through 12; third, that the figure represents the greatest possible increase in conservation knowledge under present educational conditions. If these assumptions are true, then an increase of 6 times 6.1, or 36.6, could be expected from grades 6 to 12. If the total score obtained by the sixth grade Caucasian pupils

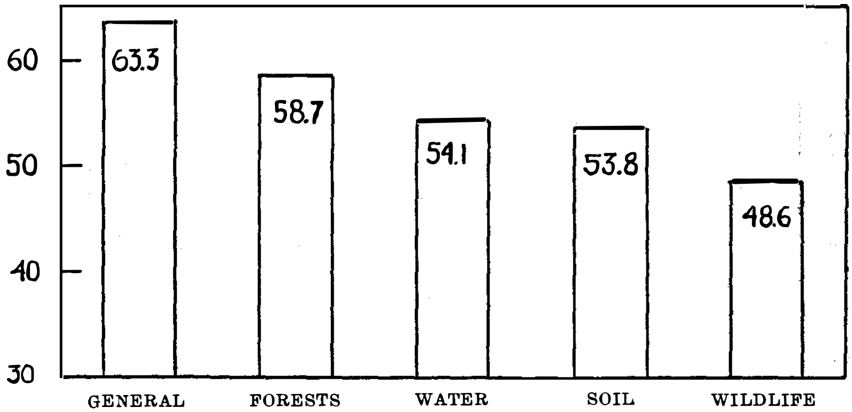

Figure 3. Statewide conservation knowledge within various resource fields.

is chosen as the score least affected by "maturity and incidental acquisitions of information," and if the point 86.3 (49.7 plus the cumulative increase between grades 6 and 12) be chosen as the *theoretical maximum increase* in conservation knowledge of Virginia school pupils under present Virginia conditions, then a theoretical curve, approximating a straight line, can be drawn. This curve, Figure 2, then represents the theoretical maximum increase in conservation knowledge. The deviation of the actual test score curve from this theoretical curve is thought to indicate proportionate deficiencies in conservation knowledge.

Boys obtained a mean total test score of 56.3; girls obtained a score of 53.9.

Caucasian pupils had significantly higher scores than did Negro pupils in almost every comparison of test scores. Statewide mean total scores were: Caucasian, 59.9; Negro, 43.6. These figures indicate a definite lack of conservation training among Negroes of the State and point out the need for broadening the present conservation education program in Virginia.

Pupils' conservation knowledge of different resources varied. Total average test scores on each section were: General, 63.3; Forests, 58.7; Water, 54.1; Soil, 53.8; and Wildlife, 48.6 (Figure 3). These results indicate deficiencies in the conservation knowledge of Virginia pupils in all resource fields but particularly in the fields of water, soil, and wildlife.

By inspecting the scores of pupils indicating participation in one or more of the ten most beneficial activities, interesting results were obtained.

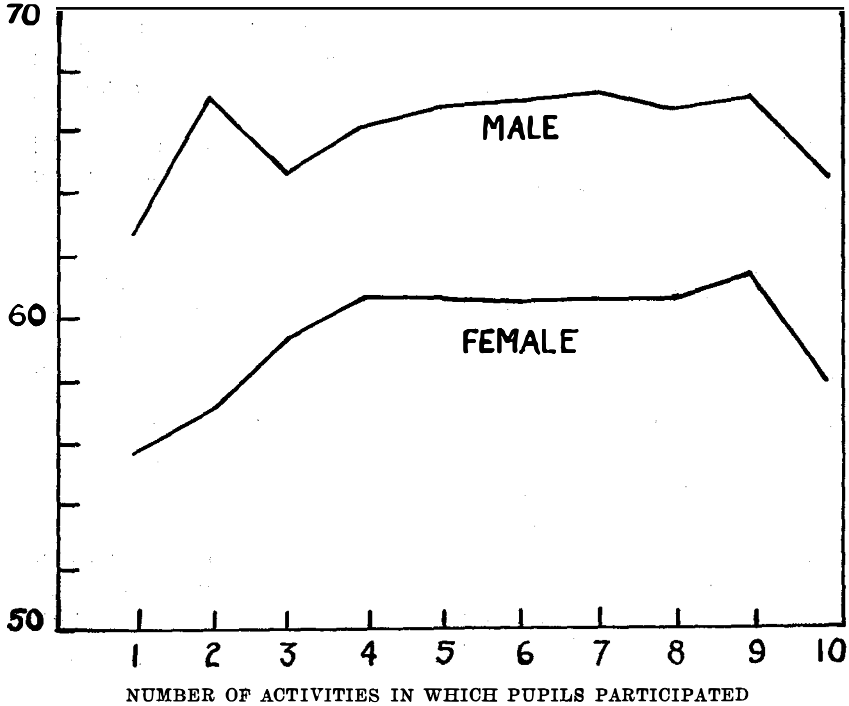

Figure 4. Relationship of mean total test scores to number of activities in which pupils participated.

Figure 4 shows that boys' conservation knowledge increases as participation in beneficial courses, memberships, and activities increases from one to seven. Conservation knowledge of boys and girls increased 52 percent as they participated in from three to six activities.

Girls' conservation knowledge did not seem to increase after participation in the fourth activity until participation in the ninth activity. Both boys and girls indicating participation in more than nine activities seemed to have less knowledge of conservation than those in fewer activities.

These results, though based on subjective data, indicate that a variety of educational methods produces good results but that there is a limit to this effect.

Miscellaneous activities written-in by pupils disclosed that those who hunt, fish, trap, and camp obtained a mean score of 75; those who were sons and daughters of professional conservationists obtained an average score of 81, the highest by them being 91.

No attempt was made to explain the number of boys indicating participation in the Girl Scouts and Campfire Girls organizations.

The three most beneficial school courses, in order, were: general science, biology, and geography. Beneficial school courses participated in by the greatest number of pupils were: general science, geography, and history.

The three most beneficial memberships, in order, were: Boy and Girl Scouts, Summer Camp, and a family interested in nature and conservation.

RESULTS OF TEACHER QUESTIONNAIRE

Four hundred and fifty teachers administered the Conservation Knowledge Test from February 1 to May 7, 1957. Sixteen per cent thought the vocabulary too difficult; all but one of the rest thought the vocabulary reasonable. Fifty-one percent of the teachers responding teach conservation in their classes. Nine percent thought conservation should be taught as a separate course; eighty-eight thought it should be integrated with other school courses. Only one thought that it should not be taught.

CONSERVATION PLACEMENT

Consideration of the factors that: (1) pupils in grades one through six have limited abilities for comprehending conservation, (2) pupil drop-out was continuous and that it accelerated between the sixth and seventh grades, (3) greatest increases in Caucasian pupils' scores occurred between grades 7 and 9, caused the writer to conclude that conservation can be most efficiently and effectively taught in grades 7, 8, and 9. If one grade is to be considered, grade 7 appears to present the greatest opportunities.

RECOMMENDATIONS

1. That conservation educators devote their efforts to increasing the amount of conservation being taught in public school grades 7 through 9, particularly grade 7.
2. That educators of rural youth reevaluate their conservation efforts to eliminate the differences in knowledge between rural and suburban youth, and take planned steps to increase the conservation knowledge of rural youth.
3. That conservation agencies cooperate closely with Boy and Girl Scout and 4-H Club organizations for an effective extra-curricular approach to teaching conservation to youth.
4. That all Virginia resource agencies critically evaluate their programs of conservation education to account for and eliminate differences in the conservation knowledge of pupils in different parts of the State and of pupils of different races.
5. That the schools, through the State Board of Education and conservation agencies, assume their responsibility for continuing and

increased conservation education in the State, integrating conservation training with their other activities, and in so doing, become the center of a vital and dynamic State conservation education program.

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DISCUSSION

DR. RICHARD WEAVER: Bob, how did you arrive at the principles upon which the test was based, and again, can you give us any idea of the cost?

MR. GILES: We originally started out by trying to list 100 principles of conservation. We sought these through textbooks, through available literature on conservation and through the individual experiences in training of the personnel at the Virginia Wildlife Research Unit. We found that it was impossible because tests were too hard to make from the resulting principles.

The principles were then constructed from the questions as we found them in textbooks, by our personal knowledge and experience, in all available conservation literature.

The cost is more than I would like to add up.

I would like to acknowledge, at this time, the support of the Wildlife Management Institute in the scholarship under which this project was conducted. The State Board of Education contributed some of their administrative assistance. The Virginia Cooperative Wildlife Research Agency through their four divisions contributed to the normal procedure, to the support and financing of this, the Virginia Game Commission, through their travel expenses. The publications costs were small. I cannot give you the whole thing. It is frightening. I would like to also acknowledge, at this time, the supervision of Dr. J. S. Lindsey, under whom the project was conducted.

MR. JOSEPH SHOMON [Chief of the Education Division of the Virginia Commission of Game and Inland Fisheries]: I would like to offer a couple of comments since I am from Virginia, and this might look like a reflection on the work that we are doing.

I am sure that that is not so, and I want to offer my congratulations to Bob Giles, to Dr. Lindsey, and to Dr. Mosby for steering such a fine young man into a research problem of this kind.

I have no critical comments to make on Bob Giles' splendid presentation. There are some points, however, that could be commented upon.

One is this: I have been knocking around these North American Wildlife Conservation Education sessions for a good many years. We have come a long ways. We did not even have at one time a conservation education session at the North American Wildlife Conference, let alone a fine paper like you heard this morning.

I remember the first session that we had with a group of 15 or 20 people participating. Look at the audience here this morning.

What is truth? That's a good question.

You might ask, what has that got to do with this presentation? The answer is simple.

We are all striving to achieve the truth, to find a way to the truth. But man is the hardest animal in the world to study. In all these conservation education sessions, we get down to the final point that resources management is largely a management of human beings. It is not so much the management of natural resources.

We have learned a great deal about the management of natural resources, so we are up against some stupendous problems. And as our complex civilization gets greater and greater and more complex, the study of this human animal gets ever greater.

You know, they tell us when a human being first learns a bit of understanding, the first thing that he learns a view towards something.

After he learns a little bit more through experience and what not, he begins to form an opinion. It is a little stronger than view.

Then as he learns more through experience and study, so the experts tell us, he begins to form a belief, but truth is way out here [indicating], and that is something that we are all trying to achieve.

When it comes to resources management, our problems are largely in the area of human relationships. And I have plead that we have studies in those areas because that is where our great problem lies. They lie in the area of the users of natural resources.

We need more research on the users of natural resources. We have not had enough of those studies and they are difficult to make. They are very difficult to make and they are very costly. Just see what the Crossley studies have done for this country in hunting and fishing, and what they have done in several of the states on a smaller area.

Ladies and gentlemen, I submit to you that this is the sort of research that should be conducted more and more. Public opinion surveys are a tool; they are a new tool and they have only certain values so far, but they have come a long way.

As to how far we have come in Virginia, I am not afraid to tell you that we have come a long way. I am wondering what a survey like this would reveal if it were conducted in the city of New York?

You know, as we get a little older and acquire a few gray hairs, we begin to learn a little about wisdom, and I recall a little of wisdom that my former boss, I. T. Quinn, told me. It was in essence this.

It isn't so much of how far we have advanced, but, good Lord, look at the depths from which we have come.

MRS. ROBERT CUSHMAN MURPHY [Seetauket, Long Island]: That was just about the best discussion that has ever been made on conservation. We can, through a plan I have, get education in conservation all across the United States. My husband, Robert Cushman Murphy, is both a conservationist and an educator.

We can get a book on America in simple, fine English and perfect conservation knowledge written to cover all conservation for the whole country.

You see, I am not a technician, but I am absolutely bubbling with enthusiasm and belief and the need to get it all across. So our program has shown that in two years we have really gotten a stand for ourselves, and our bulletins are published in many of the Long Island papers.

Then when we get the book done, which I will illustrate a little, presently, we can get a bill through that would require knowledge of this book for every promotion, every diploma, every teaching certificate.

To finance it is a simple thing; we wouldn't have to ask any money from the government. We have got probably Harper's, they are my publishers; and they will publish it.

I would use practically all the royalties, keeping back enough for expenses, and get a few grants, and one foundation is helping me.

We could get free advertising by having this thing take like wildfire. Such a thing might sweep the whole country, which is already very much aroused. I believe this could be done, but we do not want too much technical work. Technicians are essential, but they do not put conservation across.

Most conservation writing is so horribly involved, as we all know.

But a technical collaborator with somebody like me, if I may say that, to work on this book, will be simple enough for the babies and beautifully written enough for the college graduates. But with Robert Cushman Murphy in the background helping us it might really get us somewhere, and if anybody has anything to say about this idea, I will be glad to hear about it.

I am simply thrilled over my own work on Long Island.

MR. HOFF [Wilmington, Delaware]: I think Mr. Giles has made a very excellent survey.

I would like to ask what the State of Virginia is doing in training teachers to teach conservation of natural resources. Do you have a conservation education laboratory for teachers, a conservation course specializing in that, and how many of the teachers and what percentage of your teachers attend such a conservation laboratory?

MR. GILES: I believe Mr. Shomon can answer that better than I.

MR. SHOMON: In 1947, when I went down to the Commission, we had almost nothing along that line.

I recommended to the Commission in 1948 that we undertake a limited conservation education program, and that we try to develop a little initiative and leadership in a state where conservation education was badly needed.

A proposal was made to the Commission, which they adopted 100 per cent in 1948. It was in essence that we attempt a double-barreled approach.

One, we should aim directly at the kids with a broad wildlife essay contest. We started that program in 1948. We had a small response. We got the sportsmen to back the program, the women to back the program. We got a few thousand essays the first year.

That essay contest is now in its 12th year.

I think we have somewhat indoctrinated some 105,000 growing boys and girls in conservation in Virginia, in the schools of Virginia, through that one essay contest. It has been consistent every year; the State Division of the Izaak Walton League of America during the past 12 years has contributed something close to $7,000 in cooperation with a cooperative program with our Commission.

The State Board of Education dragged its feet. They had a series of workshops in conservation; they didn't get anywhere for a very long time. They had a coordinator conservation Commissioner, and his position was shaky. He was elevated to the position of research.

For years, there was nothing done along teacher-training lines. No single teacher-training school in Virginia offered one single course in conservation.

I, and many others, recognized the problem. We organized a Virignia Youth Resource Education Series, bringing together both resource people and educators to see if we could do something about this problem. And we did.

We had no money. But today the Resource Educational Council through an annual budget has some private money to work with, all through contributions of $9,000.

We started one at VMI, one at the colored State Teachers College in Virginia, and one at Richmond, Virginia. Those workshops have been going on with eminent success over the past three years. We have turned out 250 teachers who have been given a two-and-a-half weeks solid course in conservation, all of conservation. They get from two-and-a-half to three hours college credit, and all their on-campus expenses are paid.

The teacher simply gives up her time. The scholarships, I would say, we have 250 scholarships ranging from $75 to $85 apiece for a teacher, and they have done much to help do the job that needs to be done.

But we have so much further to go. We are only one agency. We are supported entirely by fish and game, with a few kickbacks by the Federal government.

The educational job, we recognize, is largely one for the State Board of Education. We are doing this in the hope that the final effort will be made by the proper agency of the State government.

MR. GILES: You will be interested to know that this week, in Utah, this same test is being administered to 8,000 people, and all the testing materials and data from the Virginia study are now in the hands of Eastern College where they will be studied further for other recommendations made after completely this study.

TELLING THE CONSERVATION STORY VIA TELEVISION

ALLEN H. BENTON

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Our educational system is the subject of much discussion and argument today, and a large part of this discussion centers around the problem of supplying competent teachers for our skyrocketing school population. One of the most attractive solutions that has been offered is the use of television, so that qualified teachers may reach a larger audience. Television has also been suggested and used as a major part of adult education programs. So far as I know, my course in conservation, over Station WRGB, Schenectady, N. Y., represents the first attempt to synthesize these two functions of television education into a conservation effort. Probably no professional educator now teaching can escape the opportunity, at least, to use television as a teaching tool. I hope that my experience will be of some help in preparing you for it.

First of all, I think that conservation, among all the classes presented over television, is ideally suited to this medium. The basic principles and concepts of conservation thought can be outlined briefly in simple charts. The problems of conservation, and the techniques employed in their solution, can be shown with the abundant visual materials available. In gathering materials for commercial television use, one must be very careful about the use of copyrighted material, but in conservation all of the vast resources of varied state and federal agencies are at your disposal and may be used freely.

Perhaps the greatest advantage of television presentation lies in the potential audience. My Hooper, Trendex, or Crosley rating was pretty low, but in an area estimated to contain some half-million sets, I reached from 5000 to 12,000 of these sets each time I went on the air. Compared to my 100 students per year in college, this looks pretty good. Many of the viewers were housewives, doing their ironing in front of the sets. There were sportsmen and farmers, businessmen and shift workers, taking a half hour out to watch the program. The program was piped into many high schools and elementary schools, where each set had numerous viewers. The letters I received indicated that I was reaching many people who did not have the necessary background to take part in ordinary adult education programs, and many others who had no opportunity to do so.

For the teacher whose experience has been limited to classroom work, and for the wildlife worker who may have occasion to use TV time, I'd like to mention a few of the special techniques which are important. In classroom teaching, most of us tend to use too few visual aids. In television, there is a temptation to use too many. A good rule of thumb is about one visual per three minutes of viewing time, with no more than five minutes of uninterrupted talking, unless you are a real spellbinder.

Variety is the spice of television, and you can use visuals of all types. Photographs, cartoons, graphs, blackboard writing and drawing, flannelboard, all are effective in certain ways, especially if they are mixed in appropriately. If you can muster a bit of humor, the light touch is especially appreciated. You can't be another Bob Hope, but you can at least maintain an aura of good humor which goes over well with the audience.

If you use any word which is not common knowledge, you will be asked to make a super. This allows one camera to photograph the word, written in white on a black background, while the other remains on the speaker, and the two pictures are superimposed so that the word appears across the bottom of the picture.

The rules for successful television visuals are the same as for other uses. Lines must be broad and heavy. Diagrams and drawings must be simple and uncluttered. The shape of the television screen must be kept constantly in mind when visuals are being prepared. Photographs must be clear and sharp, preferably on matte paper. Size of photographs is not of great importance, though the cameramen would prefer 5 x 7 or larger. In a pinch, pictures as small as two inches square will telecast successfully.

Television as an educational tool has its disadvantages too. For the beginner, the worst problem is timing. The television authorities are even more strict than the chairmen of papers sessions. You can't stop for the day with five minutes left, nor can you keep your students for a minute or two after the bell. In a half-hour program, you'll probably have 27½ minutes and will be expected to fill it within 15 seconds.

Lack of a visible audience is sometimes frustrating. Are your stories getting across? Does anyone have any questions? Does your personality project through the glassy-eyed tube? These are, at the minimum, mental hazards. Then, too, rehearsal time is limited, if available at all, and this may cause difficulties. Demonstrations must be tested before presentation, since your eye cannot judge accurately what will show up on the television screen. Further, you don't have a captive audience. Your periods are short, and in a series it is hard to maintain continuity. You have to win your audience in the first minute, hold them for the next 26, and persuade them to come back next time.

Still, for better or for worse, educational television is here, and it seems likely to expand for years to come. I believe that conservationists have a challenge and an opportunity in television teaching, particularly in reaching the adult population with the conservation story. Though television teaching is somewhat different from classroom teaching, the adjustment can be made with relative speed and ease, and the results are well worth the effort.

DISCUSSION

MR. PREVOST [Quebec, Canada]: In Montreal, we have made certain experiments with TV, too, through Radio Canada.

As you know, we have a Federal radio there with no private citizen involved. And we found that if we can get conservation through some programs like Sports in Review and have about five minutes of a program on conservation it attracts a lot of people.

We have other programs, too, on conservation, but very often we prefer if we get only five minutes so we are sure to get the greater population listening to our program and we estimate—we have two channels, one is French, and one is in English, in Montreal with a population of two million people—we can reach 400,000 people.

So, even if we have only five minutes we think that we do much better than with a half-hour program where they might turn to another channel.

I think if it is done in many places like that, we will come to get some results and again. I am in favor of TV and I think that the TV medium is the best one to reach the whole population.

DR. BENTON: This comment is much in line with the problem in conservation education, of whether you ought to have a conservation course or whether you ought to integrate.

In other words, in this particular case you are integrating your conservation in other programs, and this has an effect with people who would not tune in for a conservation course, but when you have got them there, maybe they will sit and listen for five minutes to something that might be of interest to them.

I may say that my course was rebroadcast from Plattsburg and Plattsburg is right below the border, so I had a Canadian audience as well as an American audience.

MR. CARL HENDERSON [Maine]: I would like to ask the speaker how he got his air time?

DR. BENTON: I knew somebody was going to ask that because quite obviously no television station is going to be so altruistic as to come out and present you with, let's say, approximately twenty-two and a half hours of free air time to do with as you please.

We have, in the Albany-Schenectady area an organization known as the Mohawk-Hudson Council for Educational Television, and they will be very happy that I plugged them here. It is a wonderful organization that puts on television educational programs over the three television stations in the Albany area at all levels; elementary, high school and college, and my course was the second college course.

It actually was a college course given for credit. You could take the course over television, pass examinations, turn in reports, and get two hours of college credit for the course and some thirty-odd people did that. They furnished the director, the technicians and the know-how, you might say.

The New York State College for Teachers, State University of New York, furnished me my mileage and my salary and the station, WRGB in Schenectady, furnished the air time.

Now, admittedly this is a unique situation that you do not find in many communities, but it gives you some ideas and if you try to go home and do the same thing I am all for it.

MR. ROLAND CLEMENT [National Audubon Society]: I would like to suggest that we can be even more optimistic, but my television experience dates from

Rhode Island just a few years ago where I did a 15-minute show for two years, and this was on their commercial show and at their invitation.

As you know, all TV has to perform in the public service, and if they have some optimism about your capabilites in producing a show for them, I think you will have a receptive audience at these commercial stations.

But I would like to point this out; unless you are so organized that you can increase your investment in the show, that its very success may lead in ultimate failure. That is what happened to me.

The show was so successful that it made absolutely impossible demands on my time, and I had to give it up. I began, first of all, by taking my name out of the telephone directory, and just had to give up because I couldn't keep up with the public demand for public information.

I became "Mr. Audubon," "Mr. Wildlife," in my area for about a million people, and the demands for advice and miscellaneous information made it necessary for me to give it up.

But I think you could at least be optimistic about getting started.

MR. HENDERSON: I would like to know if you have any prepared scripts? Did you use tests to evaluate the results of your program and are these materials available?

DR. BENTON: I did have prepared scripts. They are not available.

I found that my particular rate of speed required 8 or 9 5 x 8 or 4 x 6 cards closely typed for a half hour or for the program that I had. I have a pile of cards in my file, but that is all.

I had to prepare a working script that gives cues for the announcer and so on.

As for tests, I gave a mid-term and final examination and required a term paper. The tests were the same tests as those I used in my college conservation course, and the results were closely comparable.

I found where it was given in several high schools, where several senior students were given the course, I found that my poorer students were my high school seniors, which indicates that my course was a college level course in every way.

MR. BARRY [Maryland]: Have you had any experience in closed circuit television in New York?

DR. BENTON: I have not. Our college has an experimental closed circuit, TV setup, and the reactions are mixed, and much depends on the course.

This would require four separate papers, but I could give you information on it, if you would like to talk with me about it.

We do have a closed circuit setup in the college. This course has never been given over it.

MR. MICHAEL HUDOBA [Sports Afield]: Mr. Chairman, I might suggest that the probability of a single shot televsion show not be overlooked.

Sometimes those single-shot efforts lead into two-year extensions of continuity.

On the closed circuit in Washington, just before vacation time, on NBC, we put on a 30-minute program called "Stop, Look and Listen," which is just a talking walk into woods as guests of nature, and the annals of woods, and it is fantastic as to the response that comes in from that activity and how longlasting the memory of those programs were made.

DR. BENTON: I think the previous question was regarding closed circuit teaching within the college. I hope that is what it was because that is what I was speaking about.

That is, we have a closed circuit room, and the instructor can teach ten or twelve sections and thus reach a large segment of the students. That is the kind of closed circuit I was referring to, at least.

MR. BARRY: I think the audience may be interested to know that the Federal Education Department is carrying on an experiment in Hagerstown, Maryland, giving considerable money for this program. They call on the conservation agencies and schedule it, and it is set for a citywide area at least three times a week to cover it effectively. I believe they are going to implement this program in other areas in the future.

A THEORY OF THE VALUE OF HUNTING

PAUL SHEPARD, JR.

Knox Collge, Galesburg, Illinois

The problem of the ethics of killing is especially acute to the biologist. Along with others, he must satisfy the perplexing questions raised by his own conscience. In addition, he bears a responsibility, especially if he is a teacher, to those who seek his counsel or take the measure of his convictions. What follows is an effort to discover a value in hunting beyond the ecological effects on populations and with implications for the ethics of killing.

Philosophical opposition to hunting is an established element of our intellectual life. Even among those devoted to conservation there are opposing views. Killing animals for the meat industry or for scientific research can be rationalized to the satisfaction of all but a few, but hunting for sport is frequently regarded as morally indefensible. In teaching and in other interpretive fields the issue is perennial. Values and attitudes are being formed. It is apparent to me that some of my acquaintances class hunting with war and murder. These critics are frequently students of humanistic desciplines, have potent weapons in a broad literary knowledge, are articulate and very keen, as it were, in the slaughter of the advocates of hunting. In a recent debate in a national magazine, for instance, Joseph Wood Krutch carved up his hunter opponent and served him to the readers—a murderer steaming in his own juices (Krutch, 1957a).

How has hunting been defended? One position is that a man's sporting activity in the field somehow prepared him for a higher plane of conduct in human affairs. This gentleman's approach became obsolete with the formality and *noblesse oblige* of an aristocratic social structure, and may never have been valid anyway. It has been held that the stalk promotes character, self-reliance, and initiative. But this Teddy Roosevelt effect is unprovable. The development of leadership does not necessarily depend on the taking of lives. Assertions are sometimes made about "instinctive needs" and vague primitive satisfactions and psychological releases. The sharpest opponents of hunting sometimes give the impression that they have not yet forgiven Darwin and Freud anyway. To suggest that hunting has psychic or evolutionary values only infuriates them. Then there is the claim that the hunter is really concerned with an "excuse" to escape the roar and friction of civilization, to squeeze out of society's trammels for a few hours of recuperation. The outraged response is, of course, that hunting with a camera is equally rewarding and more uplifting. And finally there is the Faulkner and Hemingway approach in which hunting is a manipulation of symbols for proving one's virility or otherwise coping with the erosion in the modern world of the human personality.

These rationalizations deserve to be junked. None of them is valid. If the real value of hunting is to get a hearing its spokesmen must insist on greater perspective by all concerned. The essential point must clearly be understood to turn on a broader philosophy of man in nature. Opposition to hunting for sport has its accusing finger on the morality of the act of killing. The answer is not a matter of forcing the admission that we are all human bipedal carnivorous mammals, damned to kill, but consists in showing through anthropology, history, and the arts that the superb human mind operates in subtle ways in the search for an equilibrium between the polarities of nature and God. To share in life is to participate in a traffic of energy and materials the ultimate origin of which is a mystery, but which has its immediate source in the bodies of plants and other animals. As a society, we may be in a danger of losing sight of this fact. It is kept most vividly before us in hunting.

The condemnation of killing wild animals for sport extends from some very provincial and anthropocentric premises. It is only a biased opinion that death is the worst of natural events. It is part of the naive assumption that order in nature is epitomized by living objects rather than the complex flow patterns of which objects are temporary formations. This view leads to the assumption that carnivorous predation as a whole is evil. A noted exponent of this idea is Albert Schweitzer, the author of the term, "reverence for life." Dr. Schweitzer, who does not believe in hunting for sport, has sprinkled his jungle writings with accounts of righteous killing of predators. (Schweitzer, 1951). Europeans and Americans have always persecuted predators —the big cats, eagles, wolves, bears.

Joseph Krutch condemns the hunter for killing and claims that the distinction between life and death is one of the most absolute boundaries which we know (Krutch, 1957b). Yet, students of biology today realize that the chain of life extends into the atomic as well as the cosmic universe, that the most satisfactory definitions and descriptions of life processes are in physical and chemical terms. The organic and the inorganic are mingled at once in the living body.

The traditional insistence upon the overwhelmingly tragic and unequivocal nature of death ignores the adaptive role of early death in most animal populations. It presumes naively that the landscape is a room-like collection of animated furniture. In this view the dissolution of body and personality cannot contribute to the orderliness which is necessary in an intelligible world. But when death is recognized in broader perspective, as transformation in a larger system, it can be seen to be an essential aspect of elegant patterns which are orderly as well as beautiful. Nowhere better than in ecology can we see that, without death, the elaborate and efficient natural community could not exist. The extremely complicated structure of this community has yet to be fully explored, but it should be noted that it is best describable in terms of events which constitute a field pattern. Plants and animals participate in it without question (*i.e.*, sinlessly) in an attitude of acceptance which in human terms would be called faith.

The unfortunate misapplication of Darwin's theory to economic and class warfare in the late 19th century can still be seen in the reluctance to accept evolution as a significant factor in man's higher as well as his more primitive activities. Evolutionary theory also had the curious effect on some people of making nature seem more instead of less chaotic, especially with Spencer's unfortunate emphasis on conflict and the "survival of the fittest." As a process evolution is unrelated to the fate of individuals. One way to confuse our understanding of the means by which organisms have become what they are is to project our notions of ethics and our terror of death into our perception of them. There is nothing gruesome in the fate of animals who die before they have lived out their potential breeding or life span; this short span is characteristic of the natural world and essential to our understanding of populations.

The problem is not only man's acceptance of death as necessary to a larger order—and therefore greater value—than himself, but of killing. The moral criterion upon which man kills plants and other animals is usually considered to limit killing to the necessity for food and defense. Under primitive conditions this meant something quite different from the modern slaughter house or the broadscale application of chemical pesticides. The events of daily life in a hunting society are permeated with universal significance. Mundane behavior associated with fundamental requirements of life are not regarded as "merely" physical, but activated by unseen spirits. While we cannot expect our society to adopt animistic superstition and awe bordering on dread, we are tempted to admire, from an ecological point of view, the poignant sense of the interpenetration of man and nature which they embody. We do not envy or strive to return to primitive ways, but we must acknowledge that its "reverence for life" is more selfless, more reverent, and better ecology than a fanatic overemphasis on death. To our highly sophisticated repugnance for soil ("dirt"), parasitism ("morbidity"), and decay ("slime") we add predation. We would prohibit it (as barbaric) from the natural landscape, extending remedial human "justice" into biotic realms where it is all but meaningless and incorporating democracy with its protection of the "weak" and containment of the "strong." Man has become a dominant in many habitats, but there is no process known by which this automatically extends his democracy or any other political or moral system into the assorting of chromosomes, the adaptations of populations, or the interrelations of species.

Is man justified in influencing this tide of death? Does he assume a terrible responsibility in selecting the victims and killing them? Besides being murderous, is he not interfering in those natural patterns and upsetting nature's balance? Such questions reveal the initial premise that man is a demi-god operating above and outside nature.

The taking of a life, so unimportant in a cosmic scheme, is nonetheless a profound event in our individual experience. Killing an animal probably does obliterate an individual awareness somewhat similar to our own consciousness. As sympathetic and vulnerable humans, we are sobered, moved, stunned by the death of any creature. This is why the tension over killing is so incisive and urgent. On one hand we have the cultural and personal necessity for tangible signs of our relationship to large-scale processes fulfilled in a moment of supreme excitement, and on the other our sympathy for a fellow creature felt most intensely at the crucial moment of death. An acceptable theory in defense of hunting must resolve these separate experiences and account for their unity.

So, the hunters' apologist must ask for a more inquiring attitude. What does the human mind itself tell us of man the hunter? Psychic well-being is associated with a mode of cultural behavior, and culture may be regarded as an interface between man and his environment. Collective dreams, myths, and symbols, such as language, change slowly with the healthy functioning of society and the mental security of its members. There is evidence in literary and pictorial arts of an iconography of hunting. The complexity of the subject is a warning that hunting is not necessarily a vestige of barbarism or in form a wanton act. What is behind the word, *venery?* It is an archaic term meaning both sexual pursuit and hunting game. What is the historical relationship between the organization of sexuality and of hunting? Is the value of hunting influenced by the human sex ratio or social patterns?

Hunting may be an inherent behavior, but it is not *only* a behavioral predisposition. It is a framework of social organization which acknowledges an extra-human context. This does not mean that killing is justified as indigenous or venerable. But it is an historical part of the activity of a people and should be regarded as having a place in the total fabric of what they have become and as a mode of their relationship to nature.

Man is at present the dominant animal of much of the terrestrial earth. The stability of his own society is related to that of the natural communities of which he is a part. If hunting promotes equilibrium within society it may benefit the stability of the natural community—which includes most of the plants and animals of the humanized landscape. These interrelationships remain to be explored in psychology, cultural anthropolgy, and ecology.

For perhaps 95% of his history man has been primarily a hunter. Not much is actually known about this past; therefore, living primitive groups supply information that may be taken as suggestive if not equivalent to past situations. The overwhelming evidence from hunting procedure among primitive peoples is that its execution is highly ritualized, a significant facet of religious worship. That we no longer worship animal gods is scarcely reason for condemning as pointless the subtle forms of the hunt. Interestingly enough, the exceptions to this tendency for the hunt to assume a formal style are found in areas of collision between hunting societies and civilized technology, where cultural deterioration has led to the breakdown of customs and to wanton killing.

Probably the richest collection of the ceremonies of propitiation of wild spirits by hunters before, during, and after the hunt is Sir James G. Frazer's *The Golden Bough*. Although perhaps anthropologically obsolete as method, Frazer's perspective and collecting genius remain monumental. To judge from the many examples he gives, hunting has been almost universally associated with ceremonial preparation and epilogue. When British Columbian Lillooet Indians disposed of the bones of their kill in a certain way, saying, "See! I treat you respectfully. Nothing shall defile you! May I be successful in hunting and trapping!" (Frazer, 1920) they are not only seeking to perpetuate their food supply. These rituals seem to solicit spiritual acquiescence and success. But such an interpretation may be the fault of our own suppositions. The ceremony makes less distinction between subject and object than we assume in the orthodox sense of magic. Frazer's view of ritual as coercive and petitionary magic was perhaps too restrictive. It also has a strong element of affirmation and communal participation. It was not only manipulative but an attuning, assimilative, and confrontative. Imitative magic is proto-technological and pre-scientific, but that part emphasizing "we-hood" and the participating in a larger whole are religious. The magic and religion in primitive ritual reveal fundamental components in the hunter's attitude. The organized ceremony simultaneously serves not only a magic and a religious purpose, but ecological and social function also. It is aimed at maintaining equilibrium in the total situation. The whole of life, corporeal and spiritual, is to be affected.

The prey, or parts of it, are killed ritually and eaten sacramentally. By following the prescribed style the hunters sacrifice the prey in evocation of events too profound for understanding. By its own self-imposed limitations the ritual hunt embodies renunciation in favor of a larger context of interrelationship. If the preliminary solicitation is effective and the traditional procedure is followed the hunt is successful. Unlike farmers who must labor in the fields and who earn by their sweat a grudging security in nature, the primitive hunter gets "something for nothing." The kill is a gift. Its bestowal depends on the conduct of the hunters. Without this gift the hunter will die. As Malinowski says, food is the main link between man and his surroundings and "by receiving it he feels the forces of destiny and providence." (Malinowski, 1948) Of all foods meat is the gift *par excellence* because shortage of protein—not shortage of food *per se,* is the essence of starvation. The elusiveness of the quarry explicitly symbolizes the continuing dependence of human life on powers beyond human control. Hunting provides the logical nucleus for the evolution of communal life with its celebrations of a biosocial participation mistique.

What do the hunt and kill actually do for the hunter? They confirm his continuity with the dynamic life of animal populations, his role in the complicated cycles of elements, in the sweep of evolution, and in the patterns of the flow of energy.

It may at first seem irrelevant to seek present values for us in the strongly schematized hunting behavior of primitive peoples. On the other hand, Richard Chase says that we have the same basic needs as primitive man. "Our deepest experience, needs, and aspirations are the same, as surely as the crucial biological and psychic transitions occur in the life of every human being and force culture to take account of them in aesthetic forms." (Chase, 1949) Many anthropologists report that there is widespread belief in the "immortality" of the spirits of all living things, a point of view which we may not be advanced enough to share. Frazer wrote about 40 years ago, "If I am right in thus interpreting the thought of primitive man, the savage view of the nature of life singularly resembles the modern scientific doctrine of the conservation of energy." The idea of organic interrelationship which ecologists explore as an inductive science may spring not from science at all but from a rather fundamental human attitude towards the landscape. (Shepard, 1958) In these terms, the hunt is a singular expression of our identity with natural processes and is carried out with veneration appropriate to the mystery of those events.

This concept transcends particular economic situations. Men in all sorts of societies—primitive, pastoral, agricultural, and technological—continue to hunt fervently. The hunt has ceased to be the main source of food, but remains the essence of a larger transaction. The prey symbolizes that which is received, whether from a host of animal gods, an arbitrary god, or from the law of probability.

It is sometimes said that hunters are cruel, insensitive, and barbaric. In fact, however, the hunter may experience life more deeply. In a poem called *Castles and Distances* Richard Wilbur writes:

"Oh, it is hunters alone
Regret the beastly pain, it is they who love the foe
That quarries out their force, and every arrow
Is feathered soft with wishes to atone;
Even the surest sword in sorrow
Bleeds for its spoiling blow.
"Sometimes, as one can see
Carved at Amboise in a high relief, on the lintel stone
Of the castle chapel, hunters have strangely come
To a mild close of the chase, bending the knee
To see from the brow bone
Of the hounded stag a cross
Grow, and the eyes clear with grace . . ."

(Wilbur, 1948)

In urban and technological situations hunting continues to put leisure classes in close touch with nature and to provoke the study of natural history and to nourish the idea of conservation. Even royalty is subject to the uncertainty of the gift. From the Middle Ages we have numerous examples of the values of the hunt, where its forms have provided a significant social structure in complex royal households and its practice has stimulated first-hand observation at a time when hearsay and past authority were the main sources of information. The unique work of Frederick II in 13th Century ornithology is an example, an advance in our understanding of birds gathered in the course of hunting trips afield. A more recent example is the work of the late Aldo Leopold. A hunter and forester, Leopold documents in his books the slow sensitizing of a man to his environment through the medium of gun and dog. He postulated a "split rail value" for hunting, a reinactment of past conditions when our contact with the natural environment and the virtues of this contact were less obscured by the conditions of modern urban life. (Leopold, 1949)

Our civilization has extended the channels of distribution of food and energy and has improved their storage to buffer lean years. The ultimate origin of food in the soil is no longer apparent to the average person. In this highly engineered and insulated atmosphere the natural world has become a peripheral relic, a strange and sometimes entertaining, sometimes frightening, curiosity. What has become of the gift? It has receeded from view except to those who seek it. They may be found in the open country trying their luck. By various arbitrary limitations, both behavioral and mechanical, the hunter evens out his technological advantage at the start. This peculiar assemblage of restraints—legal, ethical, and physical—constitute sportsmanship, a contemporary ritual. The hunt is arbitrarily limited. The hunter brings to focus his whole physical and spiritual attention on the moment of the kill. He expects to eat the quarry although it is diatetically irrelevant.

It follows that hunting is not, as even hunters sometimes claim, just an excuse to get out of doors, to which killing is incidental. Killing and eating the prey are the most important things that hunters do. The successful hunt is a solemn event, and yet it is done in a spirit of joy. It puts modern man for a moment in vital rapport with a universe from which civilization tends to separate him in an illusion of superiority and independence. The natural environment will always be mysterious, evoking an awe to be shared among all men who take the trouble to see it. If modern sportsmanship is a shallow substitute for the complex mythology or unifying ceremony of other cultures some reasons are apparent: only a part of the society hunts; and the ritual forms of this technological era are still young and poorly defined.

Regardless of technological advance, man remains part of and dependent on nature. The necessity of signifying and recognizing this relationship remains. The hunter is our agent of awareness. He is not only an observer but a participant and receiver. He knows that man is a member of a natural community and that the processes of nature will never become so well understood that faith will cease to be important.

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DISCUSSION

MR. ZERN: I would like to say, incidentally, that this problem that Dr. Shepard is talking about is not a dilemma for me.

My hunting involves the expenditure of a great deal of energy and of money and no killing whatsoever.

MR. OLLIE FINK [Friends of the Land]: I do not have a question, but I enjoyed the paper very much. I would like to pass on some information in case some of you may not have read a recent publication giving research from California Technological Institute by Dr. Went and others in their climatic studies, largely of desert plants.

But in this problem, I am not a scientist; I am an educator. This ideal, however, of the survival of the fittest as far as plant life is concerned, is something I always assumed to be existing out here on the landscape and for all those who believe that, this technical bulletin is in the Scientific American series, and the title of the book is either "Plant Life," or "Plant Book," and it gives the scientific review within the past year.

It was genuinely fascinating book to me with the illustrations that they give debunking the idea that survival of the fittest exists in plant life. Also, that dormant seeds are able to indicate the amount of rainfall.

MR. GEORGE LAMB [Philadelphia]: I haven't a question. I would just like to comment that I think that this was a most eloquent testimony against the present practice of stocking directly to the gun. I think this practice removes the sportsmen from the contention that Dr. Shepard has elucidated for us.

MR. R. K. DAVIS [Columbus, Ohio]: This paper represents a battleground on which we are going to be playing a much greater role as our culture matures and our country fills.

We, in Ohio, have a peculiar situation in that it is generalized not as it pertains to the bob-white quail which we haven't hunted for 13 years, but over the country in the fact that we draw lines on certain species which are huntable and certain species which are not.

Now, I would like to hear Dr. Shepard comment on this question because as we look to the future, we face the question of redefining these lines.

DR. SHEPARD: You have got me on the spot, because I once proposed, to the unhappiness of some of my wildlife friends, that we abandon the hunting of mourning doves. I am not sure where you are going to draw the line, because the criteria that I was attempting to propose in terms of setting out with a balance between the techniques and your chances doesn't necessarily involve the kind of species. Primitive man does not have the problem of the dooryard species.

Probably, however, they are going to have to become a part of the philosophy of hunting, and I am not sure what the criteria are going to be that will be used to draw this line.

MR. RAY FOSBERG [Michigan Survey]: I would like to draw the attention of anyone who enjoyed this paper, as I did, to a series of three small books by H. P. Sheldon.

One of them, the first, is "Tranquility," the second, "Tranquility Revisited," and the third, I think, was "Tranquility Regained."

These books present an aspect of the philosophy brought out in this paper and are extremely readable and in an extremely effective fashion, as well as being some of the best literature that I know of that has been produced in the last couple of decades in this country.

MR. ZERN: I think that possibly all of them are Derrydale Press Books, and are probably in a trade edition, too.

RESPONSIBILITIES TO CONSERVATIONISTS IN FOREIGN LANDS

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We can look back upon the development of our wildlife conservation policies here in the United States with some pride and yet with regret. Had we been able to have forseen earlier the need for the development of our concepts of wildlife management, undoubtedly we would have more or even different areas set aside for wildlife here in the United States. Once, though the need for the wise use of our natural resources was recognized primarily during the administration of Theodore Roosevelt, in a remarkably short time we brought order out of chaos, and can now look with pride upon the strides we have made as a nation in wildlife conservation and management. These meetings being conducted here in New York with the wide scope of material being presented, and discussed by technically trained personnel, educators and other interested participants are ample proof of these strides. Throughout the country many colleges and universities offer courses in conservation and wildlife management. Graduate work is offered in a number of these institutions. We have thus set standards for training our personnel and large numbers of highly skilled technicians are employed in federal, state, and private wildlife management projects. It is little wonder then that foreign countries more and more are looking to us for technical knowledge, guidance and assistance.

It was my privilege, a year ago, to make a six months tour of Central and South Africa traveling over 16,000 miles, primarily by automobile, visiting a large number of the game preserves and refuges in these areas, conferring with local game officials, exchanging ideas and concepts. This work was patterned after a survey that I made as part of my graduate studies visiting many of our wildlife refuges in the United States to compare and evaluate their educational contributions to the general public as well as to the technical field. During that time I became acquainted with many of our wildlife refuge managers, learning of their work, the problems they faced and their progress. During my travels in Africa I saw many of the same technical problems even though the fauna was different and the natives presented many problems foreign to us.

The trip began in the Belgium Congo. For the most part contacts had been made ahead, often with a few key officials who made further arrangements for me to meet others. I found the various park officials not only cordial in their willingness to show me about and to explain their activities but keenly interested and surprisingly aware of what was going on here in the United States. Often as I sat at meals with these park or refuge managers, talking with them informally, I could not help but learn of their work in experiences, problems and their aspirations. This, I believe, permitted me to see situations in quite a different light from that of the casual observer who romps quickly through Africa or flies over for a well planned and highly expensive safari. I came to respect these men, to admire them, and to find them just as dedicated to their work as our own refuge managers. I only wish in some measure that they could have more help and encouragement. I was appalled at the meager libraries that most of them had at their disposal. Many times I was asked if there might be something I might do for them in return for the kindness they did for me. The answer was usually always, "Yes, send us as much information as you can about wildlife conservation in your country, both general and technical."

I found the same story through British East Africa and the Rhodesias. Although in British East Africa the officials in charge of the parks and refuge programs are better established than those in the Belgium Congo and seemed to have the necessary government and private support for their program. They did speak of the possibility of a greater exchange of ideas between their workers and ours. They felt fortunate in having some support and assistance through the Fulbright program in Uganda. There, an impressively large-scale program of wildlife management was underway with a sincere effort to bring management concepts to East Africa, an effort which seems imperative to check the depletion of the fauna in the areas. This work was being carried out by several of our well-known authorities on big game management. If only such work could be carried out in other sections of Africa. The Fulbright program has brought a renewed inspiration to local game officials who have for a long time felt that they were fighting a hopeless task.

In British East Africa I had the definite feeling that the United States had some responsibility for assisting them in their conservation and management program particularly in the technical field. One has only to spend a short time at the Norfolk or New Stanley Hotels in Nairobi to realize how many of our American citizens have a hand in the continuing exploitation of African game, and how little concern they show for any conservation measures. While perhaps this has only minor significance yet I was aware that we do have a moral obligation here.

Moving south through Tanganyika the story was repeated. The game conservator for Tanganyika had come from French Africa where he had had considerable experience in game protection work. He had come to Tanganyika because he felt that there was little hope for wildlife protection in the French sector and he wanted to work where their was at least the possibility of some future. The Serengetti plains of Tanganyika contain what is felt to be some of the largest concentrations of big game in all Africa. Yet the area north of this vast preserve, into which much of the game moves during the dry season, is an open hunting ground and herds have rapidly been diminishing. Even the lion, once so common, is so much reduced in numbers that game officials are beginning to think in terms of such predators as part of the ecological pattern rather than an animal to be destroyed or taken for trophy. In Southern Rhodesia the story was indeed difficult to comprehend. There had been a severe drought, and due to misunderstandings among the big land owners and game preserve officials, they had been forced to put up fences to keep much of the big game from water in order to preserve it for livestock. Traveling through the vast Wankie Game Reserve, I saw time and time again large numbers of animals clustered at the fences, no water within their reach and many perishing at this point, much to the dismay of the game officials who had no say in controlling the matter. Here, as in the case of our country in the early days when big game roamed in unaccountable numbers, the general public was indifferent or even demanded the reduction of the herds. We can sincerely hope that in the Africa of tomorrow there will be a place for the preservation of these species.

In Portuguese East Africa big game hunting seems to flourish on a grand and uncontrolled scale. It must be acknowledged that Colonel Stevenson-Hamilton who developed and established Kruger National Park has done much to establish some semblance of game protection in the adjacent areas of Portuguese East Africa, more properly called Mozambique. Today, near the city of Biera is the Gorangoza Game Preserve. The Portuguese are just beginning to realize the value of game preserves in offering needed protection for wildlife but also as tourist attractions. It is sincrely hoped that the program of game protection in Mozambique will expand and include areas where game is endangered.

The assistant director of the travel company who had the small concession in the Gorangoza, when he learned of my interest in conservation immediately arranged for me to meet the superintendent. While the superintendent spoke no English, an interpreter was soon found, and I was for two days a guest of the officials. The superintendent showed me his collection of publications on American wildlife management and conservation and demonstrated his ability to comprehend English. He was aware of the Fulbright program and had already sought information about it.

Kruger Park has been well described by many, as an effective, outstanding wildlife reserve, established and developed by the foresight and wisdom of Colonel Stevenson-Hamilton. Yet in my latest correspondence with the present director, he asked again for any reprints which might be made available to him and spoke about how much his contacts with game officials from the United States had meant.

The Director of Parks and Wildlife Conservation for Natal told me in great detail of his trip to the United States. He had longed to see some of our federal wildlife refuges and national parks. He had saved for some time to be able to make such a trip since it could not be financed by his office. Before he got any farther west than Yellowstone his meager funds gave out, making it necessary to cut his trip short and return to his home office. He has no immediate hopes of another trip to this country but he spoke of his desire to send some of his young colleagues to travel and study game management in the United States. He spoke of one, Mr. Peter Potter, Chief Game Conservator of Zululand whose father had established the first wildlife protection area in all South Africa and almost single-handedly had worked to bring about the Hluhluwie game preserve. Here is the last stand in South Africa and perhaps all Africa for the magnificent white rhinos. Mr. Potter has met and conferred with a number of our wildlife management men who had found their way to the Hluhluwie in an effort to carry out the most effective policies for the rhino's protection and range development. His meager library indicates how keenly interested he is in our wildlife management program in this country, and unquestionably his library was a working one.

One cannot help but think; if only some of our foreign aid could be going in this direction. Yes, it seems to me that we do have an obligation, a moral obligation if you wish to call it that, in helping to protect and preserve the distinct fauna of the African continent. Of course it goes without saying that the International Committee on Game Protection is keenly aware of the African problems and in no small measure has worked in this direction, but the work that needs to be done is a huge, even a seemingly unsurmountable task. It appears too, with the political situation as it is today in Africa, that local governments can offer little assistance or even interest in such work. We are prepared with our vast technical skill to render valuable assistance in aiding their management programs before it is too late. We should, and must give them the financial assistance and technical aid as well as helping them train the necessary personnel. Here perhaps, is one of the most important avenues where we can be of the greatest help. More than that, we can help them to develop their technical libraries and keeping them up to date. Particularly in the Belgium Congo there seems to be a great need for our assistance. While it seems strange that these rich, vastly wealthy sections of the earth have given little thought to preservation of any natural resources, while vast sums have been taken from these countries by colonial governments. Before becoming too critical however, we have only to look back on our own development in these areas to understand this situation.

Perhaps I am wrong, perhaps this isn't our responsibility, perhaps it isn't our concern—yet where does our concern for wildlife conservation and management stop? In my travels I saw in Africa, just as in this country, individuals dedicated to their work often making personal sacrifices to help alleviate the ruthless destruction of big game and to assure its proper management, for its perpetuation. These people are worthy of our assistance. Further, I believe we should seek help for them from every possible avenue, particularly from our Federal Government.

It is conceivable that perhaps in some measure such assistance might ever help to bring about a greater understanding, which is so much needed today, between the white and black races on that continent. What can and needs to be done is dependent upon our interest as well as our actions.

DISCUSSION

MR. ROBERT GILES: It seems that wildlife conservation is an evolutionary process.

I would like to hear your statements or those of other officials on this; aren't they in Africa going through the same thing that we have here in America; first, preservation, the establishment of preserves, without considerations of the modern findings in underharvest and the like? Isn't it a pattern of changing land use rather than overhunting?

DR. WANAMAKER: I think Mr. Giles certainly is right in his statement.

However, it seems to me that we can certainly help them by perhaps stepping in with the technical knowledge that we have gained through experience, and perhaps, forestall some of the needless persecution of big game and perhaps setting up a practice wildlife management program over there before it is too late.

ECOLOGY IN THE HIGH SCHOOL: "A NEW ATTACK ON AN OLD PROBLEM"

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Education divisions within state conservation departments have struggled long and hard in recent years to teach conservation in the public schools, as well as in the adult community. Public resistance to recent deer legislation, restriction of bounty payments, closure of warm-water fish hatcheries, and the cessation of extensive pheasant rearing programs has shown the education job to be no small task for the conservation educationalists. Additional and costly conflicts between administrative units within the conservation hierarchy have resulted when one bureau advocates more and more wet-land drainage while others oppose the same; when massive insecticide and herbicide spraying programs are pressed by one governmental agency and vigorously resisted by another; and when we disperse soil bank payments from one hand and at the same time dispense subsidy payments for un-needed crops with the other. Such policy contrasts only add to the confusion of the lay public.

We, as individuals, consume energy and materials at a staggering rate. Automobiles, clothing, household furnishings are all discarded and scrapped long before their full usefulness has been realized. Our attitudes toward over-production of the human race; use, or misuse, of our land resource; and complete ignorance of many of the ecologic principles applying to all communities indicate that all is not well within our society. Every school child is taught a definition for conservation, every adult will agree that conservation is important; and yet, every one of us falls down, in one way or another, in our moral treatment of our environment. I suggest that the need for conservation arises out of man's misuse of his surroundings, and that this misuse is a direct result of ecologic ignorance of the problems of the human population. If man were to live in ecologic harmony with his environment, conservation would follow naturally. Therefore, I submit that conservation be presented to the public as a problem with its roots buried deep within human ecology. The complex interrelationships between man and the environment are not obvious or easily understood. If we wish to provide for greater ecological understanding from the public, we must incorporate ecology within our educational program for the general populace. The high school seems to be the most logical place to teach the ethics and responsibilities of

[1]In the absence of the author, this paper was read by Mr. Robert H. Giles, Jr.

resource use. And within the high school, the biology course becomes the most obvious portion of the curriculum for inclusion of human ecology subject matter.

Half of the nation's high school biology teachers are not biology majors. For them the textbook is the vital foundation upon which the biology course must be constructed. Other biology teachers, though they may have experience and training enough to individualize their course content, must rely upon the textbook because of heavy teaching loads. Therefore, the high school biology textbook is now, and will, no doubt, remain of key importance in the success of biology education for some time to come. A recent study of high school biology textbooks (Blanc, 1957) has shown that textbook authors pay lip service to conservation by placing it at the top of a list of the most important subject matter areas. Yet in actual emphasis, the structure and function of leaves was given the greatest attention while conservation topics were generally ranked ninth. This becomes significant because the unit on conservation has been the conventional mechanism whereby man's environmental problems have been introduced. Bullington (1956) points out that genetics, conservation, ecology, and vocational materials have been added to the biology curricula. He then states, "The remainder of the subject matter in most texts is traditional. Much of it may be traced back to the early courses in botany and zoology." In general, the high school biology texts I have reviewed insert a chapter on conservation somewhere near the rear of the book where there's a 50-50 chance it may never be reached during the school year. And ecology, while it is defined and a few basic concepts identified, *is not applied to the human race!* Dr. Paul Sears (1954) states, "The 75 to 90 per cent of our beginning students who take no further work in biology will presently be faced with decisions in their own community, whether urban or rural, that can be much more intelligently made if these students understand a few ecological principles. Yet if one examines the textbooks and syllabuses used in many introductory courses, one finds that ecology, if there is any, has been dragged in by the heels, when it should have been used to give perspective to the whole course." You, who are teachers, may feel that I am putting undue emphasis upon the textbook. However, most of us do make use of textbooks and within the high school course the textbook may make a far-reaching contribution to the success of the course. For this reason, the biology text must be one of the first items to which we should turn our attention when implementing human ecology in the curricula.

One of the more popular high school textbooks of today is broken down into units on plant life, plant's effects on man, the microscopic world, simple animal life, animals with backbones, human biology, biology of disease, reproduction and heredity, etc. Most of the biological textbooks currently used in high school seem to follow somewhat this same pattern. I would suggest that we study units on communities and the populations of which they are composed. Particular emphasis would be given the dependence of each member of the community upon other elements, both physical and biotic. Why couldn't disease be taught as the competition between organism and the result of environmental hazards? Perhaps physiology of both plants and animals might best be presented as adaptations to the environment, demonstrating how form and function have evolved through time. The microscopic world would become just another community where cooperation between green plants, herbivores, carnivores, parasites, saprophytes, commensals, and others might be discussed. I cannot conceive of a single aspect of the current biology curricula that could not be included as a natural part of a course in human ecology. But many concepts of energy relationships, ecosystems, ecologic balances, overpopulations, competition, individual adaptability, and social cooperation could be included within the ecology course that are not now a part of the formal biology program.

I do not suggest that we ignore the cellular approach to biology now being used in the college course, with its increased emphasis on the physical-chemical processes carried on within the living cell. It is a matter of question, however, how much of this newer material has been included within the high school biology course. The ecologist long ago learned the impossibility of understanding the role of a population within the community without taking into account the effect of physical-chemical inter-relationships with the organism and the environment. And so, the basic cell as a unit of structure and the living, single-celled animal or plant become an integral part of the ecology centered biology course. Neither is it my intent to convey the opinion that ecology is an all-inclusive biological science, although this view is held by some ecologists. I do believe, as already pointed out, that ecology provides a logical approach and unifying theme to teaching the wide range of biological principles.

To produce an ecologically conscious citizen, it then becomes necessary to change our biological training from the structural-functional approach of today to a more vital study of the biotic and physical environments, with their interactions and relationships stressed—keeping man as the central and unifying theme throughout. But biology is all too thinly spread already, attempting to cover the entire field of subject matter. We must give priority to fewer problems, studying these intensively. And certainly, the most fundamental and essential problem facing our society is the ability of man to live in harmony with his environment rather than destroying it. I believe Odum (1953) has beautifully stated the problem in saying, "As a result of the evolution of the central nervous system and brain, man has gradually become the most powerful organism, as far as the ability to modify the operation of ecosystems is concerned. Man's power to change and control seems to be increasing faster than man's realization and understanding of the results of the profound changes of which he is now capable. . . . Tinkering with basic ecosystems of the world can result either in a glorious future for mankind, or in his complete destruction if too many large scale mistakes are made."

I believe we biology teachers must work together and selectively thin out the overcrowded seedlings in our garden of biological principles. It is not always easy to pull out the corn plant growing too near its neighbor, but unless one is removed they both will develop into stunted specimens, worthless at harvest time. And the ecologists must assist in the selection and implementation of basic ideas of human ecology so that as complete a picture as possible might be presented to the high school student. With an ecologically aware populace, the public relations and education problems of the resource manager will become greatly minimized as compared to present day barriers to public understanding. If enough of us are interested in bringing ecology to the high school curriculum, and using ecological concepts as the foundation for human biology; then we must organize an integrated study group composed of ecologists, biology teachers, and conservation educationalists. Furthermore, such a group of workers would need the assistance of organizations such as The Wildlife Management Institute, The National Association of Biology Teachers, The Ecological Society of America, and The National Science Foundation. The time is now upon us, with study groups presently engaged in the examination and revitalization of high school physical science and mathematics programs, to modernize the biology course and to change conservation from a homage-paid attitude to a harmonious way of life.

Upon recognizing the problem and conceiving a solution, we must next decide upon a means of implementing our proposed answer. In order to achieve a widespread change in the high school curriculum, the people who teach the subject matter must be convinced of the merit of the proposed change. This means that the new biology course must be prepared in a manner similar to that suggested above and given test trials in classrooms across the nation. Teacher and student opinions may be utilized in reworking the material. During this time interval, every means possible should be employed to keep the biology teachers and school administrators informed as to the progress being made in preparing the new program. Finally, the polished work could be published on a cost basis, or in whatever economically feasible manner that the sponsoring organizations might direct. There is no question as to the time, energy, and dollars that a project such as this would consume. And yet, in my mind there is no doubt as to the final value of such an effort to the conservation movement. There has been no small effort made in the past to provide the school teacher with conservation materials and teaching aids. All too often, such information never reaches the student. But where ecologic attitudes and land ethics are integral units of the biology course, every student will have opportunity to benefit from such good sense and conservation education will take a great stride forward by striking at the core of our problem—wanton waste and misuse of our energy and resources.

In closing, think if you will, of a nation whose people comprehend the problems of overpopulation, of food shortage, of biotic interrelationships. A populace that realizes the significance of the energy cycle and knows that soil is a living entity rather than "just dirt." A citizenry aware that beans come from something other than a can and that a water faucet does not guarantee water. If the people of this country are already so informed, then my suggestion is out of order. However, I am afraid that we are not only ignorant, as a people, of Aldo Leopold's *land ethic,* but are heading at an ever faster pace away from it. Supremely confident of "superior" man's ability to conquer all, we continue to ravish and destroy our environment. We must learn, and very soon, what happens to every animal species when the population exceeds the carrying capacity of the habitat. But before the misuse and abuse of our environment can be corrected, the disastrous consequences of such a way of living must be taught. This remains the obligation of education, and human ecology is the vehicle from which we can launch a new attack on the old problem of man's misuse of this planet he calls home.

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DISCUSSION

DR. RICHARD WEAVER: I won't attempt to put Bob on the spot to answer questions, but I want to make comment:

The paper that Hiden Cox gave yesterday certainly is germane to this.

I think the present review or the evaluation of the high school program will be along, as he indicated, ecological lines, so that the comment I have pertains to the conservation part.

I had an opportunity within the last three years to enter a team of three to prepare a biology book with conservation ecology as the major emphasis, and we discovered in the process of looking through the other books that Curtis and Urban had tried to put ecology and conservation in the beginning of their books, in the first hundred pages or so. They have had to change their text, and I think I know why, after having tried to write the same kind of thing.

Photosynthesis, the energy cycle, the carbon cycle, the nitrogen cycle, the water cycle and all the others must be included. When you put conservation in at the start, it hits about the middle of the year, and most of the teachers prefer to discuss physiology, genetics and evolution and put conservation and ecology at the end and discuss it when it comes up in the spring.

This is only an assumption that they are going to complete the book.

It has been found that many do skip to that section, and that is not a disadvantage. The things they skip most are evolution and genetics. Some people object to this.

But having in the back of the book a course on ecology like this is not a disadvantage. They do a lot of training to get through a 600-page book.

I think the greatest advantage of handling photosynthesis in junior high school, in the lower science course, is that your lower science course can be the integrating course and then you can have ecology at a senior level.

The present course of trying to cover the whole field of biology is not working, and it is too much in one year. So, I think we have the job of introducing it at the lower level with basic biology, and having it go up to the advanced senior level.

MR. HAPP [Pacifica College]: I certainly concur in the speaker's presentation of the importance of using human ecology as a value of teaching general biology, and I certainly will speak of the fact that it is certainly a useful tool of not only the high school level, but also in the college level.

It seems to me we are in a new atmosphere of using man's ecological aspects and, in an introductory aspect of biology, we have tried this on a college level and found it functional. It has difficulties and lots of things you have to adjust to, but it certainly has basic values.

MR. GILES: After studying this paper several times, I should like to issue an early warning that it will be very easy for the same thing to happen in ecology that has happened in conservation. This word can be a catch-all.

Some people will say ecology when they mean sociology. The field is unlimited. It is an interrelated sort of thing, and I think all of us ought to keep our interests pretty well pinpointed and straight down the line as to what we mean by ecology, just as we should have kept in mind what we mean by conservation and we won't have the problems with ecology 10 to 20 years from now as we are having with conservation after that same length of time.

HELPING SCHOOLS STUDY WILDLIFE

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When you were a school child, did you find that sitting at a desk, writing on the blackboard, and reading from a textbook were often boring—a bit tame? Did you look out the window from time to time and long to see a glimpse of wildlife that would pep things up a bit? I certainly did; and often my longing to be outdoors interfered with my school work. It could have been otherwise: my natural interest in wildlife could have stimulated me to much better class work.

Indeed, toward the end of high school a wise teacher of German had me clip and translate natural history news from a German newspaper and allowed me to read *Bambi* in the original German. Then I felt a real need for German and study became a joy—except during spring warbler migration when almost nothing could keep my mind indoors.

Today thousands of wise teachers capitalize on children's natural interest in wildlife, especially in the primary grades; but thousands more don't, especially in the higher grades. Even those who do use wildlife to help motivate their pupils often fumble through ignorance of animals and fail to pursue the facts and concepts of wildlife ecology which could be so helpful in our efforts to train future citizens.

Wonderful as many of our teachers are, their own science training has left most of them a bunch of biological illiterates (except for knowledge of the human body and maybe the frog), and their art training has often given more attention to self-expression than to perception of nature. Fortunately our institutions for teacher training are beginning to retool for nature education again. Also, increasing numbers of teachers are getting helpful in-service training in night courses and summer workshops. But still the great majority need much more help in learning about wildlife and how to use it in their teaching of many subjects.

This recognized need is not easily supplied. Many of us with knowledge of wildlife are already overloaded and are just too busy to help. A few have the time and knowledge but are not confident of their ability in a school situation. Some of us have tried to help but have been rejected by school administrators. So just how can we tactfully help at this time when almost everybody is criticizing the schools and telling them how to run their business?

Looking around at what is already being done gives us both facts and encouragement. For instance, the Audubon Junior Clubs show us one excellent way, helping teachers create interest-groups within the schools. The National Wildlife Federation's educational work is giving fine support through such means as National Wildlife Week, whose theme this year of course is "Conservation in the Schools." Certain state conservation departments are doing outstanding work cooperating with school systems; the lagging states should emulate them. The National Association of Biology Teachers is running a series of articles on Outdoor Laboratories in its journal; we should be contributing articles on wildlife management for these teachers. More books in the tradition of the late Dr. Eschmeyer in his True-To-Life Series need to be written. Yes, we need more work of just the sort that many of you have already been doing—a lot more work!

There is one way of helping which is very important but which has been barely begun: *helping schools study wildlife on their school grounds.* To be sure, the live specimen brought into the classroom helps, but it is apt to be a sad specimen before long in its artificial, classroom habitat and it lacks the ecologic significance of wildlife leading a relatively normal life on properly managed school grounds. Students need some outdoor study of animal populations, life cycles, territories, food habits, and habitats, and not just once but from week to week and year to year. Now three problems arise:

First: Most teachers don't know how to study wildlife outside a book, much less outside a classroom.

Second: The superintendent or principal may frown on outdoor studies (never having had any when he was a boy).

Third: The school grounds may be very poor wildlife habitat. But these difficulties are not insuperable. So here are six first steps for those who really want to help schools study wildlife.

FIRST STEPS

(1) Interview the superintendent of your community's school system. Ask:

a. Are any schools using their grounds for education other than physical education?

b. Is there a principal who might be interested in experimenting at his school with outdoor education with special reference to wildlife?

c. Is there a teacher of biology or general science who is doing a particularly good job teaching outdoors, or if not, indoors?

Ask permission to visit any of the above to observe.—Try to end your interview with the superintendent in less than ten minutes, showing you are businesslike and that you know he is very busy. Even if all his replies are negative, end on a positive note, listening to whatever he is proud about in his school system. Don't offer any help yet, not even if the answers seem favorable.

(2) Interview similarly the superintendents of any neighboring school systems close enough so that you could work with them.

(3) Decide which of the above school systems has the administration most inclined toward outdoor education on school grounds. Revisit the appropriate superintendent and offer to help at *one* school experimentally with a *wildlife approach to outdoor education correlated with classroom work.* Specify the duration of the time you can help, say two hours a week at the school until May 15th. If your offer is accepted, proceed to Step 4; otherwise try another superintendent.

(4) With the superintendent, select a first-choice and a second-choice school with:

a. The most promising principal for support of such work, and/or

b. An exceptionally interested or capable teacher or teachers, and/or

c. Favorable grounds in terms of extent and/or variety of habitats.

(5) Through the superintendent, arrange a conference with the principal of the first-choice school. He will want to please the superintendent but should be given ample opportunity to decline your help. Should he refuse, be understanding and try the second-choice school—and hope for better luck.

(6) Suggest to the principal the following possibilities:

a. He initiate a Schoolgrounds Conservation Committee of students and staff to which you can act as adviser.

b. You work with one or two interested teachers, visiting their classes, bringing in an animal, getting the class to look out the window and wonder about wildlife, and taking them on a very short "wildlife trip" around the building to look at wildlife habitats (perhaps only ant hills and sparrow roosts). Outside of class hours, you discuss with the teacher possible ways of correlating the wildlife studies with the regular class work. You favor some of the teacher's ideas—they may be better than yours.

(I hope that the above steps seem logical, based on common rules of human relations and resource management. Not having any special training in extension work, I have made many mistakes before learning even this much about working with schools. For instance, I lost one whole year working under an enthusiastic superintendent for a principal who had almost no sympathy with anything we did outside the building. The children and teachers did seem to learn considerable but the excellent school grounds have since been largely unused and then despoiled by the administration, ruining the opportunities for future outdoor education. Now the superintendent has left and the system's science education is geared to interplanetary gadgetry with nearer nature completely out of focus.)

MAPS

Have the students procure or make copies of all existing maps of the school area. *Social science* students can look up historical maps at the library, historical museum, tax assessor's office, registry of deeds, or homes of oldest citizens. *Natural science* classes can contact the local U. S. Soil Conservation Service, state agricultural extension service, or conservation department for information on aerial photographs, and should then ask the principal to buy contact prints for stereography plus an enlargement to help in making a base map. *Mathematics* pupils can make actual field surveys to gather data (distances and angles) for an up-to-date base map.

Drafting of the original of a new base map can be by classes in *art* or *mechanical drawing*. The base map should be very plain, with only the more permanent features useful for reference. More complicated special maps will subsequently be superimposed on copies of this base map. Include simple north-points, graphic scale, and date in an out-of-the-way spot, leaving at least one large blank area for keys to the special maps made later.

Reproductions of the base map should be at two scales. Small-scale maps should for convenience fit on 8½ by 11-inch sheets and can usually be mimeographed at school. Large-scale maps should be perhaps 2 by 3 feet, filed in a special place where they can be kept flat; these can be printed by a high school printing class or commercial printer. Large-scale maps should also be prepared in overlapping sections used for field work and local studies; these can be mimeographed on 8½ by 11-inch sheets.

INVENTORIES

Have the students use the base map for recording inventories of many types of natural resources: topography, microclimates, soil, water, vegetation, and of course wildlife of various kinds at various times of day and season. These studies should be correlated with classroom work and can involve arts and languages as well as the sciences. Verbal and pictorial records should accompany maps. Any one kind of map can be made at almost any grade level according to the abilities of the students at that level. Some inventories can be made by whole classes; others can be by teams or individuals. The best work should be systematically filed for future reference. These inventories can advantageously carry on year after year.

PLANNING

Have the Schoolgrounds Conservation Committee work out long-range plans for maximum use of the school grounds in many subjects, based on the inventories. If at all possible, strive to include along with the playing fields and parking lots a picnic grove, rough grasslands and forblands, brushlands, treelands, and wetlands. Try to set samples aside as natural areas to be managed with minimum disturbance. Then designate other areas of these types to be managed intensively, to compare with the natural areas used as experimental controls. Where these major types of habitat are lacking, consider establishing them by grading, planting, fencing, or other means.

MANAGEMENT

Counsel the teachers about these projects on managed areas. Help them to understand multiple use of natural resources and how wildlife values relate to wise management of soil, water, and vegetation. Don't get sucked into teaching classes yourself while the teacher takes a (much-needed) respite in the teachers' room. Rather work to help the teacher by supplying information, ideas, and teaching techniques to make his job more pleasant and productive. Bolster his confidence in himself as a naturalist and make his students increasingly proud of him. Of course don't ever show him up in front of his students; if he needs correcting, do it later and have him straighten the matter out with the class at its next meeting. . . . Here are some general headings for management projects for the students:

Improving Soil: Soil fertility and stability should always be considered when making plantings for wildlife, to insure denser, better nourished wildlife populations—and better education. One school brought in loam by the wheelbarrow-full to cover sterile soil, studying the physics of wheelbarrow mechanics in the process.

Providing Additional Cover: Unfortunately landscape destruction is still the rule at most new school sites. To compensate, planting should create food, escape cover, and breeding sites for a variety of wildlife. Particular attention should be given to hedges and screen plantings which will serve as wildlife pathways to the school building, especially to wildlife feeders on its sheltered sides (but keep tall shrubbery away from roads because children might suddenly emerge in front of cars). Plantings for wildlife feeding stations can be designed jointly by science, art and home economics classes to include a demonstration barbecue area.

Fences to exclude children from odd corners can give vegetation a chance to grow. Brush piles, wood piles, stone piles and walls are helpful. Old linoleum laid on the ground or tacked to a large tree will provide cover for invertebrates. Insects can be used to teach many wildlife lessons and should not be neglected even though they are seldom of primary interest to wildlife managers (except as nuisances in wood duck boxes and gallinaceous guzzlers!) Plantings to attract insects, especially bees, are to be recommended. Bird houses are an old standby still worth considering but are of course less basic than broader types of habitat management.

Increasing Density of Cover: Planting, pruning to stimulate denser growth, selective cutting, girdling, and chemical spraying of trees to release groundcover, fertilizing, and irrigating can improve density of vegetational cover under certain conditions.

Increasing Edge: Intermix habitats for maximum edge in certain areas.

Improving Water Conditions: The many possibilities range from supplying conventional birdbaths to modifying streams and ponds (with care to preserve natural areas, of course, as in all the above). While not being spectacular, improving groundwater condition by insoak can greatly improve wildlife habitats.

Supplementing Natural Foods: Feeding stations and salt licks (where legal) of course disrupt normal dispersion of wildlife populations but they help concentrate wildlife where pupils can study it more readily. Have the students discuss pros and cons before any action is taken.

CONTINUING STUDIES

Eagerness to improve conditions for wildlife must never be allowed to obscure the educational aims of the school. It is what children learn that is really important for the future of our wildlife resources, not the size of the wildlife population which we may be able to build on the school grounds. In sciences, encourage accurate observation, systematic recording, and the making and testing of hypotheses. In arts, encourage sensitive perception and subjective interpretation of reality. There is a place for Kipling's "brushes of comets' hair" as well as the more matter-of-fact camera in studying school grounds.

Help the principal encourage teachers to include wildlife studies in all the subjects. Too often the school grounds are psychologically divided between the biology teacher and the athletic coach, with no other teacher daring to invade their territories. But teachers of art, music, and languages can help children find both source material and inspiration in wildlife and its natural environment. And the social sciences should be mightily involved in studying the history of land use and resource use in the region and on the school grounds and should have much to say in the land use planning for the school as differing groups try to work out the sharing of the resources.

Perhaps as I have talked you have visualized a beautiful campus of a new regional high school with infinite possibilities of wildlife management. But possibly the best school in your area is a city school where all plantings must be done in a window box and wildlife shelters may protect only house sparrows and wasps. If so, don't be discouraged! The important thing is that in either environment children will be caring for natural resources and learning to apply to human problems the valuable lessons which wildlife populations can teach.

I wish to acknowledge the help which I have received from Springfield College in my studies of outdoor education on school grounds, and from the many schools which have welcomed me, and to call particular attention to the support by the Nature Conservancy. The Conservancy's National Committee on Natural Areas for Schools is preparing helpful literature along these lines. If you wish to receive samples, please leave me your name and address. We need your help in helping schools study wildlife.

RESOURCES, PEOPLE, AND SPACE: A CRITIQUE OF THE 24TH NORTH AMERICAN WILDLIFE CONFERENCE

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It may not show, but there are reassuring aspects of being tagged as conference summarizer. One is you will never be asked again. Another is that your severest critics will not stay around to hear you. This being a situation in which anyone can let himself go a bit, I probably will do so.

Among people who are concerned for the future of mankind, there is growing awareness of a critical relationship between resources, populations, and living standards. The subject is discussed ever more freely in the public press, even to recognizing that the human irruption we are witnessing might well get out of hand. Too many people? Not long ago that disrespectful idea would get you an argument anywhere. Of course, it still does, the difference being that today's heretic can find other nearby heretics to help him out.

Our conference theme, "Resources, People, and Space," is the statement of a problem. By implication, it is a problem worthy of study and potentially subject to solution. To visualize it more concretely I have devised a purely figurative equation as follows:

$$\frac{\text{Resources} \times \text{Culture}}{\text{Number of People}} = \text{Living standard}$$

This formula is for conceptual, rather than practical, purposes. It represents man's adjustment to his environment as being totally dynamic, which is an ecological viewpoint and, I think, realistic. I should add that for extremely sparse populations these indicated relationships would not always hold, but otherwise they probably do.

The only entity in this formula is resources—the earth itself, its natural riches and its space. Culture is the efficiency with which we convert the resource base to human use. At various cultural levels man was a hunter and fisherman, a herdsman, an agriculturalist, finally a scientist. It was cultural changes that Malthus could not predict, and this has confused many of our latter-day issues. I cannot agree with Secretary Bennett's view that Malthus was basically wrong. The biology was sound enough. Malthus simply did not foresee the industrial revolution. Obviously, we are still revolting at an ever-increasing rate.

But human numbers around the earth are growing even more rapidly. This inheres in the fact that our culture, our technology—probably civilization itself—exists in the minds of only X per cent of the human race; whereas all men know how to reproduce without high-level guidance. It is reliably predictable that those who insist on multiplying will also be forced to divide.

That too is in the formula, since living standard is represented as the end result of the best and worst we can do. If we are asked to declare our final aim in using resources, I suppose our only defensible position must be that we are after a high level of living for the individual.

A high level of living—it is a noble thought. But when we get to working with it, the trouble starts. Some of the decisions must be for tomorrow, rather than today. They must involve the conservation conscience Monroe Bush talked about yesterday afternoon. He pointed out that people are not much concerned about shortages of the future; and the farther away such problems are, the less responsibility we are likely to feel for them. Quite clearly, altruism may be strong as a principle, but it is weak as a motive.

Here is a good place to review our definition of conservation. Last year we celebrated (some of us) the centennial birthday of Theodore Roosevelt. The word conservation was added to our vocabulary about 1905, by Roosevelt and his associates. Gifford Pinchot said that W. J. McGee, a forester, defined it in classic clarity as "use of the natural resources for the greatest good of the greatest number for the longest time."

Assuming responsibility for the future certainly is a matter of conscience, but it also involves scientific analysis and judgment. Hiden Cox told of many ways in which science is implementing our conservation needs. The technical sessions of our meeting attest this in great detail.

Beyond any doubt, we are using the scientific specialist to good effect. The specialist—he tells us *how to do things.* But what of the generalist, who could tell us sometimes *whether they should be done?* Just to see the issues may require some insight into the basic nature of habitats and the mechanics of populations. This morning in this room you heard some remarks by F. Fraser Darling, one of the world's foremost ecologists, who is now studying conservation problems in Africa. In planning our own resource use how often do we think to call in a Frank Darling to make an appraisal in terms of fifty years hence? Sometimes people don't seem to want that kind of answer. Ignorance can be a rewarding state of mind.

Great problems of strategy are posed in the writings of Julian Huxley, Fraser Darling, Paul Sears, William Vogt, Robert Cook, Fairfield Osborn, Lee Dice, Samuel Ordway, Harrison Brown, and others. But does Congress know such problems exist? Or is the old, expanding economy fixation all the guidance our government requires? Do legislators and administrators consciously believe that a nation, now using 40-odd per cent of the world's yield of raw materials, can go on multiplying its demands forever?

The answers to these questions are in all the newspapers. They are in every issue of the Congressional Record. And they are not convincing terms of reference for a people who would, as Dean Cleveland said, "sell conservation around the world." Yet John Wanamaker emphasized how anxious the professional conservationists of other nations are to have contact with their own kind in North America. In testimony to this, it is good to have on this program the paper on wildlife in East Africa by Simon and Treichel. I think a deeply philosophic question is raised by what is going on in Africa. They are skinning off the primitive fauna and flora in order to raise maximum numbers of tame natives. We have contributed to this trend around the earth. In righteous self-assurance, we call it progress. I wish that sometimes we might find the wisdom and insight to see when we are just setting up the pins so some communist dictator can throw a ten-strike.

As I have implied, there is a respectable scientific discipline behind our conservation philosophy and program. It can be called ecology, or environmental biology. For the most part, I think it has two levels of abstraction. The first deals with management of the human habitat; the second concerns population responses and living standards. As regards the first, this conference offers outstanding contributions.

Few human habitat problems are more generally pressing than that of keeping our waters clean and usable. The papers by Ordway and Frost on the first session brought home to us vividly the effects of population build-up and the resulting legal and social involvements in this field.

I said keeping our waters clean and usable—maybe I should have said keeping our waters—period. In an era of drainage that is fast producing a crisis for aquatic wildlife, it is good to hear of trends in the other direction. Victor Lambou described fishery research on 18 Louisiana impoundments totalling some 100 thousand acres. Among management techniques, he mentioned the one called "drawdown." We hear more about this every year. It is relatively new and gratifyingly effective in some situations. A summer drawdown of impounded waters can be used to thin out overpopulated panfish and reduce competition for food. It is likewise used to promote the growth of food crops for waterfowl. We can see excellent possibilities here for coordinated management.

I do not know of any kind of wildlife habitat improvement where we can see results so quickly as we can in putting some water on the land. In a few seasons, small, man-made waters can produce wildlife and measurable recreation benefits. This was nicely pointed up in Byrd's paper on Alabama public fishing lakes.

One of the most timely fishery reports on this program was Needham's nationwide summary of artificial trout stocking. Year by year, our put-and-take programs of all kinds come under continuing technical scrutiny, and they show up less favorably right along. After analyzing some 244 planting experiments with marked trout, Needham commented, "The continuing waste of millions of dollars in rearing and planting fish that never reach the creel is appalling." He found the benefits of trout stocking to be scant and restricted to relatively few anglers. In areas of great demand, he sees the need for special-regulation trout fishing to emphasize sport and to spread the catch among more individuals. Undoubtedly, this is a trend of the future in many recreational fields.

I think it is worth noting here that the largest increase in the budget for the Bureau of Sport Fisheries and Wildlife, which the President recently sent to Congress, was an item of $421,000 for the operation of fish hatcheries. This program is politically popular, but it is a mistaken public demand. I do not doubt for a moment that there are places in the bureau—including the neglected sport-fishery research program—where this money could be better spent than on fish hatcheries.

On the further subject of fish, I think it significant that there were three papers which concerned Alaskan salmon. Especially encouraging was the prospect held out by Royce of greatly increasing the production of young fish by improving conditions in gravel spawning beds. Webster Clark studied the effect of Kodiak bears on spawning salmon in the streams of that island, and he reports no cause for alarm. I liked his attitude that both bears and salmon are public resources needing proper protection and restoration.

Mathisen has an even touchier problem on sea lions and their relationship to commercial fishing. The fact-gathering is much in order. There has been heavy pressure to control sea lions, as well as nearly every creature in and around Alaskan waters that might eat fish or be otherwise troublesome. When decisions are made, we hope it can be kept in mind that eagles, bears, beluga whales, hair seals, and sea lions belong to the whole public, just as do the fish themselves. Cropping fish commercially is a privilege to be enjoyed on good behavior, and not a right to be won by political processes. The decline of one fishery after another bears witness that this principle is yet to be established as a working policy.

Ordway cited the urgency of finding legal concord in cropping and managing resources that overrun international and other types of political boundaries. As a case in point, all of us can hope for proper international action to conserve and perpetuate the polar bear and walrus. The bears are being hunted outside territorial waters with aircraft, a situation that could easily get out of hand. Walrus killing has been out of hand for a century or more and is in need of immediate regulation. There should be continued field studies and regular reports of the kind presented here by Scott, Kenyon, and Buckley.

An entire session of this conference was devoted to the question of pesticides and their effects on game, fish, and other wildlife. The subject was authoritatively handled in seven papers that sampled the issues and summarized where we stand. Harlow Mills placed the problem in proper perspective. Back of it all, he said, is the burgeoning of human numbers and the drive for greater production. Chemical pest control will be with us from now on and under some conditions will result in wildlife damage. Mills aptly noted that the true ecological significance of hazard and damage must be determined by research rather than theorizing.

Dan Leedy's report on research needs, coupled with the fact that the President's budget still contains an item to support this work, leaves us with the cautiously optimistic outlook that wildlife-pesticide relationships will have more adequate investigation in the future than in the past. This is further fortified by the papers on insecticide residues by Chisholm and Cannon, respectively, the paper on water pollution studies by Tarzwell, and Glasgow's review of field investigations in the controversial fire ant program. The complex and difficult problem of repellents has had long and faithful attention at the Denver Wildlife Research Laboratory and the Patuxent Research Refuge. Besser's paper indicates convincingly how the team approach and sustained effort pays off.

There are at least four contributions in this year's conference that should be of particular interest to administrators. One concerns our perennial search for efficient, inexpensive survey techniques as exemplified by Sheldon's aerial cover mapping of the entire State of Massachusetts. The photos show cover details for areas as small as 10 acres. This is an administrative aid of the highest order. Periodic surveys can give information on the condition of game range, the wasting away of wetlands, and other vital aspects of management. Men who participated thirty years ago in great operations like Michigan's Land Economics Survey, tramping through the brush with a Jacob staff and chain, can well look wistfully at these new aerial techniques.

Harry Ruhl gave us an up-to-the-minute sketch of deer management in populous areas and in forest lands of the Lake States. Particularly noteworthy was his account of Michigan's practical application of the multiple-use concept. In that state forest-cutting and planting plans are reviewed by game specialists, and large wood-using industries are cooperating in the long-time program to create a more productive range for the whitetail. In effect, Michigan has its own working equivalent of the federal Coordination Act, uncomplicated by pork-barrel pressures.

Wisconsin's experience in the intensive management of their public hunting grounds will also be generally useful. Smith reviewed a diversity of problems and indicated where they are headed in solving them.

I think administrators will reflect with satisfaction on Douglas Pimlott's account of moose harvesting in Newfoundland. It is a curious reality that governments with only a short history of wildlife research can sometimes do an outstanding job of management, once they have the facts. Moose were introduced into Newfoundland early in this century. In 1950, Provincial officials began studying their problems. They provided for browse and forest-reproduction surveys —then opened the season on both sexes! They now kill about 5,000 moose per year, which they can well afford to do. They use a zoning system to distribute hunting pressure, and kill reports are required by law. This they did in only about five years of technical studies.

Said Pimlott, "The Provincial Legislature does not have any direct role in establishing big game seasons." What manner of legislature is this, that does not spend its time on technical details? Where are the pressure groups who should have risen to open rebellion against liberalizing the legal kill? It might be constructive if this news could get through to the right people in Alaska, where biologists have talked for years about the need for harvesting both sexes on the Kenai Moose Range. We could wish for the over-conservative deer hunters of Pennsylvania to consider this program. Probably Newfoundland is too far away. It is farther still from Michigan, and altogether too far from California.

Transactions of the North American Wildlife Conference are a repository for every kind of knowledge and philosophy pertaining to wildlife and other renewable resources. They are an indispensable reference library for any serious worker and a veritable outdoor encyclopedia to the man who is isolated and dependent on his own bookshelf.

This year's volume will contain an especially useful array of papers on management methods, natural history, and study techniques.

Several have important management implications: Paul Scheffer and Olan Dillon gave reports on the increasing problem of producing food for migrating waterfowl. Vohs' discussion of wide-row corn culture described another of those agricultural practices offering hope as a means of improving game habitat. Baskett and Tomlinson investigated benefit payments in relation to quail management. Sad to relate, payments alone may merely intensify agriculture to the detriment of wildlife. It reminds us forcibly that this program needs technical direction. There is a special significance to the paper by Cottam and Glazener on late-nesting water birds in Texas. This is one of the first technical reports from the Welder Wildlife Foundation. In years to come, this private research station will be a continuing source of new information in the wildlife field. We can hope the idea catches on in other parts of the country.

Annually, at the North American, there is an appraisal of our current status in reaching the people with conservation facts. This recognizes that our biggest obstacle in doing what we ought to do is the failure of the public to feel a need for providence in resource use. Bramble assures us that the tide has not yet turned and we still are going behind at nearly every level of educational effort.

This emphasizes that conservation must be instilled in our mores and morals as a way of life; and for real changes in concepts and attitude, work with young people offers the greatest promise. It is reassuring that this field is developing its own particular specialists and technology. The trend can be seen in the reports by Benton, Giles, Cornwell, and Brainerd, respectively.

Some of the most modern ideas expressed in these programs concerned our living space and what is happening to it. This afternoon the discussions by Sheidt and Higbee described how we are tying up our land almost irrevocably and multiplying the problems of local government by allowing one urban center to build out to the next. We obliterate recreation lands and cover up fertile acres that will be needed for food production in years not far ahead. Higbee stated realistically that the human population has an unlimited capacity to expand. Does this not force us to the conclusion that the answer to our space problem must be a courageous and for-keeps zoning to preserve against all pressures on our local elbowroom and the wild areas farther afield that Brower defended so convincingly?

How else can we serve the recreational requirement that Rockefeller sees as essential in future living standards? It was satisfying indeed to hear him describe the far-sighted realism with which the new Outdoor Recreation Resources Review Commission is going about its task. We wish some other operations of the government were as soundly based.

The space issue is with us now, but we have not seen anything like the pressures still ahead. There is no natural value from coast to coast and for miles out to sea that someone is not watching with a personal plan. Land prices are feeling the competition, and responsible authorities in many areas are coming to the view that in the next ten years we will do most of what is to be done about reserving land and water for public purposes.

It is an open question whether the knowledge and concepts expressed in this 24th conference can find their way into working policy. Look out of those windows and you will see how people can be forced to live, layer upon layer, in aluminum and concrete castles in the smog. No doubt they can be fed on synthetic rations and transported gloriously from New York to California while ingesting their daily quota. But, so help me, I am not sure what it proves.

For some of us reactionaries there is a lingering doubt that the ultimate nobility of man can be realized by making him a cage-reared guinea pig. We suspect he does better in a more diverse habitat—one with lots of "edge" and a good interspersion of types. He needs space in which to satisfy his territorial impulses. He should have loafing and dusting areas, extensive, well-watered tracts of early and late plant successions in which to lead his young. There should be wild, productive ranges for the pursuit of prey in autumn.

These things are a part of the good life that people have taken for granted in the past. It seems to be our job to make sure they are not forgotten.

ACKNOWLEDGMENT OF APPRECIATION

C. R. GUTERMUTH

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

After listening to this splendid summarization and critique by Dr. Allen, I am sure that all of you can appreciate what a job it is to summarize a program of this magnitude.

I always am delighted to see this Conference come to a close for many reasons, but at the same time it is rather disheartening to see an end to the many profound and astute presentations that we have had in this series of meetings.

A presentation like that of Dave Brower's is the sort of thing that should be spread widely around this country.

The comments by Dr. Allen are fundamental and basic, and while I am not trying to sell his books, you will find them crammed with the same practicalities cover to cover. His book, *Our Wildlife Legacy*, should be listed among the modern classics.

Some of Durward's statements, which brought forth smiles and seemed humorous, really were pathetic when we think how badly they needed to be said. Millions of people have crowded themselves into this smog, and into this maze of cliff-dwelling habitations and human sweatshops that surround us here in this hotel. When I came back to the Statler in a cab the other day, I could not help but see, on one of the crossover streets, an impressive and thought-provoking sign. It portrayed a child and referred to church services or something of that kind. The sign read, "Not by bread alone." I could not help but think that we should have brought that poster up here, but then you are not the people that we should be trying to reach. Those that we need to reach are the ones who could give us the research appropriations that we need, and that Dr. Allen mentioned.

I spend much time at hearings in Washington, and often see Congressional committees appropriate hundreds of millions of dollars for various projects here and abroad, and always wonder if any of those legislators ever stop to think where we get those hundreds of millions of dollars. They come from our basic natural resources, many of which are limited. Some are renewable, of course, but what about the nonrenewable resources that gave us other billions of dollars?

In a meeting in Houston the other day, Mr. Brower, some dignified attorney from Denver was asked to tell those people from all parts of the country about the Wilderness Bill—this is cited merely as an illustration of general misunderstanding—and when he got through they asked me to comment. My answer was, "Well, you should have called on me first. It is too late in the day to start an argument, but I am wondering if this gentleman who has been frightening you about that pending legislation ever read the Wilderness Bill? I am confident, from what he said, that he has not read it from end to end, because he certainly does not know what he was talking about. That bill would not do half the things that he has said, and has inferred."

In behalf of the Wildlife Management Institute, I want to thank not only Dr. Allen but all of the organizations and agencies and individuals that have contributed to the success of these meetings.

We want to thank the members of The Wildlife Society and American Fisheries Society, and Lawrence V. Compton in particular, who served as the chairman of the Technical Sessions.

We have been discussing the quality of the program this year, and the casual praise is evidence enough, Lawrence, that you and your associates on the Program Committee did an outstanding job—thanks very much.

Speaking for all of the conservationists throughout North America, thanks to the press. Dan Poole told me gleefully that the press coverage has been the best we have had at one of these conferences for several years; so thanks to the press and to the radio and TV.

We want to thank the Statler; there has been practically no criticism. The New York Convention and Visitors' Bureau also has our good will for its cooperation in providing the help and assistance needed to handle the large registration.

You obviously enjoyed the banquet last night. Everyone seemed to like the show. At least, it was loud. There was abundant applause, so I feel as though it was a success.

This annual occasion is the only time that I have an opportunity to pay my respects to those two charming persons that keep Dr. Gabe and me going year after year. They are here right to the last as usual, and today, March 4, 1959, makes it 37 years that I have lived with one of these patient ladies. If you please, I want both Mrs. Gabrielson and Mrs. Gutermuth to stand up and take a bow.

Many of you have inquired about the total attendance. When I checked shortly after noon, we had an actual enrollment of 1,059 persons, which means that we must have had around 1,300 or 1,400 present. We rarely get more than an 80 per cent enrollment, so 1,300 is a safe estimate. At the banquet last night, they served at least 587 people.

The number of related meetings that are being held in connection with these Conferences is getting beyond one's comprehension. We had a three-page list to start with and added a long supplementary list. I finally gave up on trying to provide meeting rooms; the groups had to meet here, there, and the other place. That sort of thing has become more a measure of the value of these Conferences than anything else.

Now, I am privileged to announce that the Conference is going to go to Dallas, Texas, next year. The dates will be March 7, 8, and 9, and the meetings will be in the new Statler Hotel. Incidentally, the meeting room facilities in that hotel are excellent. We are looking forward to seeing all of you there. A pleasant trip home and happy landings.

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